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Education Department Bulletin

Published fortnightly by the University of the State of New York

Entered as second-class matter June 24, 1908, at the Post Office at Albany, N. Y., under the act of July 16, 1894

No. 490 ALBANY, N. Y. MARCH 1, 1911

New York State Museum

JOHN M. CLARKE, Director
EPHRAIM PORTER FELT, State Entomologist

Museum Bulletin 147

26th REPORT OF THE STATE ENTOMOLOGIST

ON

INJURIOUS AND OTHER INSECTS

OF THE

STATE OF NEW YORK

1910

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New York State Education Department
Science Division, December 21, 1910

Hon. Andrew S. Draper LL.D.
Commissioner of Education

DEAR SIR: I have the honor to communicate herewith for publication as a bulletin of the State Museum the Annual Report of the State Entomologist, for the fiscal year ending September 30, 1910.

Very respectfully
JOHN M. CLARKE
Director

STATE OF NEW YORK
EDUCATION DEPARTMENT
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Approved for publication this 22d day of December 1910

A. S. Draper

Commissioner of Education

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UNIV. OF CALIFORNIA

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JOHN M. CLARKE, Director

EPHRAIM PORTER FELT, State Entomologist

Museum Bulletin 147

26th REPORT OF THE STATE ENTOMOLOGIST, 1910

To John M. Clarke, Director of Science Division

I have the honor of presenting herewith my report on the injurious and other insects of the State of New York for the year ending October 15, 1910.

The past season has been remarkably quiet so far as unusual outbreaks of injurious insects are concerned. The entomologist was exceptionally fortunate in discovering a colony of pedogenetic larvae, presumably those of Miastor americana. These extremely peculiar forms were previously unknown in this country and have been studied by only a few Europeans. A summarized account of these interesting larvae is given in an appendix.

Fruit tree pests. The experimental work with the codling moth was continued the present season under more diverse conditions, and data which will be of great value in the practical control of this species, was secured. The experiments were conducted in the orchards of W. H. Hart, Poughkeepsie; C. R. Shons, Washingtonville and William Hotaling, Kinderhook. Great pains were taken to secure an ample number of trees likely to produce a nearly uniform amount of fruit. Each plot, as last year, except in the case of Mr Hotaling's orchard, consisted of 42 trees, the fruit from the central six alone being counted. Comparisons were made to ascertain the relative efficacy of one spray given just after the blossoms dropped, with this treatment supplemented by a second application

about three weeks later. The unusual abundance of the codling moth the past season renders the data secured of exceptional value because they show the possibilities under very adverse conditions. Assistant State Entomologist Young aided in the field work and was responsible in large measure for the computation of the tabulated data. These experiments and their application are discussed on subsequent pages.

The San José scale is still very destructive, especially to peach trees, though our progressive orchardists have comparatively little difficulty in controlling it. A lime-sulfur wash, particularly that known as the concentrated wash, either homemade or commercial, has proved very satisfactory, as a rule, in checking this pest. There was complaint of injury by the cherry maggot in the Hudson valley and an investigation of the pest and methods of controlling it was inaugurated. The cherry and pear slug was exceptionally abundant in this region and also in the western part of the State. The pear psylla was somewhat numerous in the lower Hudson valley and reports of serious injuries were received from certain sections in the western part of the State.

The work of a new apple pest which may be known as the lined red bug (Lygidea mendax Reut.) was observed in the Hudson valley. This insect occurs in early spring, lives upon the more tender terminal leaves and, under favorable conditions, may inflict considerable injury.

Shade tree pests. The injurious work of various species has been brought to our notice. The more important of the shade tree pests is the elm leaf beetle, a well known form which has been exceedingly abundant on Long Island, throughout the Hudson valley and in certain cities in the western part of the State. The sugar maple borer has been unusually numerous on the trees of Fulton, Oswego county, destroying or practically ruining a number of magnificent trees. The cottony maple scale has been somewhat abundant in the lower Hudson valley, while the injurious work of the false maple scale was observed in several localities in the vicinity of New York city.

Forest insects. The snow-white linden moth, a pest which has been very destructive in the Catskills for the past three years, was abundant in limited localities last season and its flight in small numbers was observed in various places. A series of outbreaks by another leaf feeder was reported from several localities. They were due to the operations of a green, white-striped caterpillar

(Xylina antennata) frequently designated as the green fruit worm. The destructive work of the hickory bark beetle, noted in a preceding report, has been continued. An unusual outbreak was that of Abbott's sawfly, a false caterpillar which stripped or nearly defoliated many white pines in the foothills of the Adirondacks. The spruce gall aphid has continued to be abundant and injurious on Norway spruce, in particular. It is interesting to record the discovery of another species of gall aphid, new to the State, occurring upon the Colorado blue spruce. The above noted insects have been the subject of correspondence and, in some instances, of field investigations during the past season.

Gipsy and brown tail moths. Much interest was aroused early in 1909 by the finding of thousands of winter nests of the brown tail moth on many shipments of French seedlings. A number of such nests occurred on shipments received in 1910, though the pests were not so abundant as during the preceding year. The careful inspection of the stock appears to have prevented this insect from becoming established in the State. There is much more danger of this moth being brought into New York State on shipments of full grown nursery stock originating in infested American territory than there is of its being introduced with imported seedlings. It has been found necessary to give considerable time to the determination of remains of caterpillars, cocoons and egg masses in order to be certain that none of these fragments on nursery stock indicated the presence of either the gipsy or brown tail moth. The mounting of such fragments has devolved upon Miss Hartman.

A personal investigation of conditions in eastern Massachusetts shows that no pains are being spared to prevent the dissemination of either the gipsy or the brown tail moth. Particular attention has been given to keeping the property abutting on the principal highways free from the pests so as to eliminate in large measure the danger of their being carried by vehicles of any kind. There has been, however, some extension of the territory occupied by these two pests. The gradual spread of these insects appears to be inevitable, though the utmost care is taken in the treatment of the outlying colonies. It is gratifying to state that the serious infestation recently discovered at Wallingford, Conn. has been handled in such a satisfactory manner that only a very few specimens rewarded a week's careful search by a gang of fifteen men. An examination of the work with parasites showed that no stone was being left unturned in an effort to find, rear and liberate a large number of

efficient enemies of these pests. The entomologist would emphasize once more the grave danger of bringing either one or both of these pests into the State on nursery stock originating in the infested area, and would call attention to the great desirability of promptly exterminating any isolated colonies which might be found in the near future.

House fly. The popular interest in the control of this pest has continued and bids fair to result in important and far-reaching sanitary changes. The demand for information along these lines speedily exhausted the edition of Museum Bulletin 129 on the *Control of Household Insects* and necessitated its republication in an extended and revised form as Museum Bulletin 136 entitled: *The Control of Flies and Other Household Insects.* The entomologist has been called upon to give a number of popular lectures upon this insect and has made personal examinations of conditions in several localities, giving special attention to situations favorable for the production of flies in cities and villages.

Gall midges. Our studies of this extensive and interesting group have been continued and the results are now in manuscript. This publication will describe fully some 800 species, 441 having been reared. The tabulation of midge galls, made with the assistance of Miss Hartman, shows that we know some 538 species representing 44 genera and living at the expense of some 177 plant genera referable to 66 plant families. In addition to the above, there are some 5 species reared from unknown plants and 11 species belonging to 3 genera known to be zoophagous.

A number of new species have been reared during the year. Miss Cora H. Clarke of Boston, Mass. has continued collecting and forwarding to us excellent series of galls from which we were able to rear several previously unknown species. The care of this material has devolved largely upon assistant D. B. Young and Miss Hartman. The latter has also made a large number of microscopic mounts of these fragile forms.

Miscellaneous. The entomologist spent nearly six weeks in Europe, giving special attention to museum methods, shade and forest tree insects and the gall midges. Collections were studied in the following institutions: British Museum of Natural History, London; the Universities of Oxford and Cambridge; the Tropical School of Medicine, Liverpool; the zoological gardens at Antwerp; the Royal Museum of Natural History at Brussels; the botanical gardens of Ghent; Museum of Natural History and also the ento-

mological station, both of Paris; the University at Zurich; the exceptionally valuable collection of forest insects in the forestry school at Munich; the natural history collections in the Senckenberg Museum at Frankfurt; the Winnertz collections in the University of Bonn; the Museum of Natural History, Berlin, and the Museum of Natural History at Hamburg. In addition, the entomologist spent several days with Prof. J. J. Kieffer of Bitsch, Germany, studying his exceptionally valuable collection of Cecidomyiidae, and a day with Prof. E. H. Rübsaamen at Remagen, Germany, which was devoted largely to examining his numerous excellent drawings and a discussion of the classification of this group. A portion of a day was spent with Oberforster H. Strohmeyer of Münster, Germany, studying his excellent collection of Scolytidae, while another day was passed with Oberforster Karl Philip at Sulzberg obtaining first-hand information of forestry methods as practised in Germany.

Publications. Numerous brief, popular accounts dealing with injurious insects have been prepared by the entomologist for the agricultural and local press, besides a few more technical papers for scientific publications. A revision of Museum Bulletin 129, as noted above, was issued during the year, while the report for 1909 appeared July last. A tabulation of the midge galls known to occur upon several plants was published in August under the title of *Gall Midges of Aster, Carya, Quercus and Salix.*

Collections. A most valuable addition to the collections was secured through the generosity of Prof. J. J. Kieffer, of Bitsch, Germany, who kindly donated to the museum a number of his generic types of European gall midges. These have been carefully mounted and are now accessible to students in the group. A fine series of Italian midge galls was secured by exchange with Dr Mario Bezzi. These were carefully arranged and labeled by Miss Hartman. Miss Cora H. Clarke, as in preceding years, has contributed some valuable biological material, mostly insect galls.

The arrangement and classification of the collection has been pushed as rapidly as possible, though it should be remembered that, with the limited office staff, it is practically impossible to keep the collections properly classified, while the securing of extremely desirable additional material must of necessity proceed slowly. The restrictions due to a small staff will become more apparent with the occupancy of quarters in the new building, accompanied by the obligation of maintaining a larger exhibit. The school teachers of

Albany, Troy and presumably other near-by localities are making extensive use of our exhibit collections in connection with the regular school work. It is the aim of the Department to have a representative collection of the species occurring in the State, though the assembling of such means the work of years.

The nearly completed monograph on the gall midges shows that the State collections in this family will far exceed anything that can be assembled elsewhere for some years to come. It will always be exceptionally valuable because of the very large series of generic types or cotypes. Assistant State Entomologist Young has identified and arranged the Conopidae, besides doing much miscellaneous work in classifying insects collected during the year and identifying species sent in for name. A number of Hemiptera have been very kindly determined by our well known authority in this group, Mr E. P. Van Duzee of Buffalo. Miss Hartman has also assisted in the arrangement of the collection and has reared and spread a number of specimens.

The value of the exhibit collections will be greatly enhanced when the fine series of plant groups, designed for the exhibition of insects in their natural environment in the new Educational Building, has been completed. The wax work for four of these groups has been delivered and it is planned to complete the remainder next year. Several excellent models representing injurious insects are now on exhibition and more should be secured, preferably made to order, since only a few can be purchased in the market, while no one has attempted to prepare models of many forms which could be exhibited in this manner to very great advantage.

Nursery inspection. There has been close cooperation with this phase of the work conducted by the State Department of Agriculture. Numerous specimens of both native and foreign insects have been submitted to this office for name, and the entomologist frequently consulted in regard to various problems. This work, while consuming much time and often necessitating identifications of minute forms, like scale insects or the recognition of species by fragments or the comparatively unknown early stages, is very important, since the treatment of large shipments must depend in great measure upon our findings.

Office matters. The general work of the office has progressed in a satisfactory manner, the assistant State entomologist being in charge of the office and responsible for the correspondence and

other matters during the absence of the entomologist in Europe and while away on vacation. Miss Hartman, in addition to matters noted above, has rendered material assistance in bibliographic work and in translating from German, French and Italian works. Numerous specimens have been received during the year for identification and many inquiries made concerning injurious forms. 1445 letters, 37 postals, 417 circulars, 1475 packages were sent through the mails and 44 packages were shipped by express.

General. The work of this office has been greatly facilitated, as in past years, by the identification of certain species through the courtesy of Dr L. O. Howard, chief of the Bureau of Entomology, U. S. Department of Agriculture, and his associates. Several correspondents have aided materially in securing valuable specimens of one kind or another, and, as heretofore, there has been a most helpful cooperation on the part of all interested in the work of this office.

Respectfully submitted

EPHRAIM PORTER FELT

State Entomologist

Office of the State Entomologist, October 15, 1910

INJURIOUS INSECTS

CODLING MOTH

Carpocapsa pomonella Linn.

The apple worm, or larva of the codling moth, is such a common pest that comparatively few appreciate the losses caused by its operations, and altogether too many regard it as a pest which it is almost useless to combat. This latter notion is a very erroneous one. There is abundant data to prove not only the possibility, but the practicability, of controlling this insect in a very satisfactory manner. This is shown in a very striking way by the experiments conducted last year. Even one thorough application resulted in the production of nearly 99 per cent of worm-free fruit, while check trees did not produce quite 73 per cent of sound fruit. These experiments were continued the present season for the purpose of testing more thoroughly and under varying conditions the relative value of one or more sprays for the control of this serious pest.

General observations. The season of 1910 has been remarkable for the development of a large second brood and a consequent prevalence of wormy apples. The work of this pest was very evident in Genesee county as well as in the Hudson valley, and in some unsprayed orchards over 50 per cent of the fruit had been injured by the apple worm. May 30th there was a severe hail storm in sections of the Hudson valley, and an examination of the wormy fruit showed that from 50 to 60 per cent of the apple worms had entered at points injured by the hail. Cacoecia larvae were rather prevalent in one orchard and their operations were very frequently followed by codling moth larvae entering at such places. Moreover, badly rusted, rough spots on the fruit were also favorite points of attack. Comparative freedom from codling moth injury was observable in orchards where pigs or sheep had been allowed to run, this being especially true if the animals had been pastured in the orchards for several years, even in those where there was no spraying. One codling moth larva was found spun up in a slight depression on the under side of an apple resting on loose soil, and

another had prepared a similar retreat for the winter on an apple before it had dropped from the tree.

Life history and habits. Before discussing the experimental work of the season we will briefly summarize the life history of this species. The apple worm, as is well known, winters in a tough, silken cocoon, usually found under the rough bark of trees. The advent of warm weather in spring, which in New York means late April and early May, is followed by the caterpillars transforming within their silken retreats to pupae, and a week or ten days after the blossoms drop the moths commence to emerge and continue to appear throughout the greater part of June. The minute, whitish eggs are deposited largely upon the leaves, though a number may be found on the young fruit. These hatch in about a week and as a consequence the young apple worms of the first brood may be entering the small apples from early in June to nearly the end of the month, or even later. The caterpillars require about four weeks to complete their growth, at which time they desert the fruit, wander to a sheltered place, spin a cocoon, transform to pupae and in about two weeks, namely the very last of July or in August, another brood of moths appears. These in turn deposit eggs which hatch in due time and the young larvae usually enter the side of the fruit. Two broods appear to be the rule in the northern fruit-growing sections of the United States, though some investigators claim a third in the southwest.

Experimental work. It was planned the present season to test, under varying conditions, the relative efficacy of but one spray given just after the blossoms fall, compared with other plots where the application just described was followed by a second about three weeks later, designed to destroy the codling moth larvae just as they are hatching, and a third plot where but one spraying was given about three weeks after the blossoms fell. This plot was designed to show the relative efficacy between the treatment at this time, which is markedly out of season, and the time applications are usually made, namely just after the bloom falls.

Series 1. This series of experiments were conducted in a young orchard belonging to Mr W. H. Hart of Arlington, near Poughkeepsie and close to Briggs Station on the Hopewell branch of the Central New England Railroad. The orchard is on a moderately high hill, the trees being thrifty, about 16 years old, 16 to 19 feet

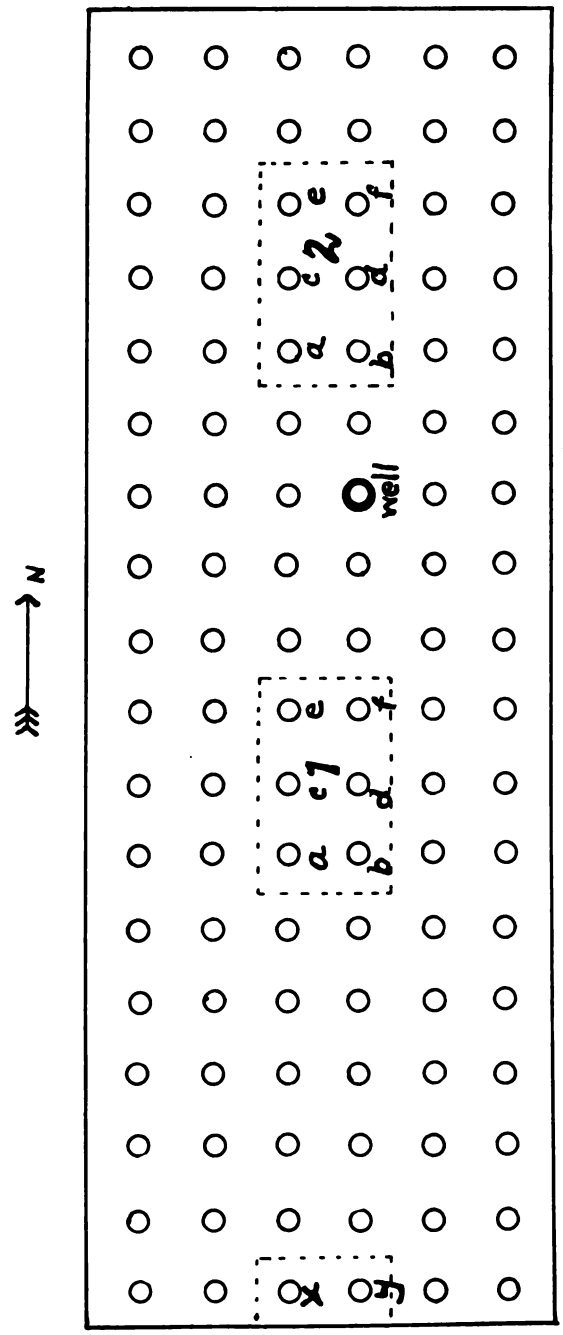

Fig. 1 Portion of orchard at Arlington showing the location of the experimental plots

high and 30 feet apart. The actual experimental trees were northern spy. Each plot consists of 42 trees, six trees in a row one way and seven in a row the other way, the central six being the actual experimental trees. These were carefully selected for uniformity in size, fruitage and infestation. There was a large crop of Baldwin apples in this orchard last year and some of the northern spys produced a fair yield. The check trees of the two plots in this orchard were located in the same north and south rows of trees near the western edge of the orchard, and were some little distance north of the road. Plots 1 and 2 were still further north. These two plots were thoroughly sprayed May 12, 1910 with seven pounds of arsenate of lead (15 per cent arsenic oxide) to each 150 gallons of spray, together with one gallon of a homemade concentrated lime-sulfur wash (Cordley formula, testing probably from 30 to 31° Baumé) to each 25 or 30 gallons of spray. The day was dry, nearly quiet and conditions were almost ideal. The pressure was maintained at from 100 to 150 pounds, Friend nozzles being employed and 150 gallons of spray sufficing for about 105 trees. All of the spraying was from the ground, the hose being tied to poles and the nozzles set at an angle so as to discharge almost directly into all the blossoms. The application was sufficiently thorough to cover practically all of the foliage in a very uniform manner. The trees were fairly well fruited and had just completed blossoming.

The second application was made on plot 2 June 2d. The day was cloudy, with a strong southwest wind and, as a consequence, the spray was applied from only one side, the eastern portion of the trees not being well covered, though special attention was given to the center where the greater portion of the fruit was located. The formula for the spray was practically the same as in the preceding application; 140 gallons were necessary to spray the plot of 42 trees. The fruit was in fine condition and the foliage had made excellent growth since the earlier application, which was plainly evident. At this time there were no signs of codling moth work.

An examination of this orchard June 30th showed a very gratifying condition. The check trees were in excellent foliage and already exhibited a markedly greater codling moth infestation. Plot 1, which received but one spraying, showed practically no wormy fruit and no signs of injury to the foliage. The same was true of plot 2 which was sprayed twice.

The fruit was picked up from under these trees and carefully classified August 23d and September 12th, the remainder being picked October 6th. The condition of the fruit on this latter date was most excellent, the color being fine, the surface smooth and a very high percentage with few defects. A tabulation of the entire data is given below.

Series 1, plot 1

TREE	DATE	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT						
			Total	%	Total	%	End wormy	End and side wormy	Side wormy	Exit hole 1	Exit hole 2
A	Aug. 23	9	6	.....	3	.....	.....	.....	3	3	.....
	Sept. 12	6	4	.....	2	.....	.....	.....	2	2	.....
	Oct. 6	148	135	.....	13	.....	.....	3	10	3	1
		163	145	88.95	18	11.05	.....	3	15	8	1
B	Aug. 23	1	1	.....	.....	.....	.....	.....	.....	.....	.....
	Sept. 12	8	5	.....	3	.....	.....	.....	3	3	.....
	Oct. 6	105	99	.....	6	.....	1	2	3	2	1
		114	105	92.10	9	7.90	1	2	6	5	1
C	Aug. 23	12	4	.....	8	.....	.....	1	7	7	.....
	Sept. 12	22	13	.....	9	.....	.....	1	8	9	.....
	Oct. 6	409	382	.....	27	.....	5	7	15	6	.....
		443	399	90.07	44	9.93	5	9	30	22	.....
D	Aug. 23	14	7	.....	7	.....	.....	.....	7	7	.....
	Sept. 12	20	13	.....	7	.....	3	.....	4	6.	.....
	Oct. 6	593	563	.....	30	.....	1	2	27	3	.....
		627	583	92.98	44	7.02	4	2	38	16	.....
E	Aug. 23	5	1	.....	4	.....	.....	.....	4	4	.....
	Sept. 12	6	6	.....	.....	.....	.....	.....	.....	.....	.....
	Oct. 6	160	139	.....	21	.....	4	3	14	5	1
		171	146	85.38	25	14.62	4	3	18	9	1
F	Aug. 23	12	3	.....	9	.....	.....	.....	9	8	.....
	Sept. 12	11	8	.....	3	.....	.....	.....	3	3	.....
	Oct. 6	298	275	.....	23	.....	2	2	19	12	.....
		321	286	89.09	35	10.91	2	2	31	23	.....
	Grand total	1839	1664	90.48	175	9.52	16	21	138	83	

Series 1, plot 2

TREE	DATE	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT						
			Total	%	Total	%	End wormy	End and side wormy	Side wormy	Exit hole 1	Exit hole 2
A	Aug. 23	12	11	.....	1	.....	.....	.....	1	1	.....
	Sept. 12	9	9	.....	.....	.....	.....	.....	.....	.....	.....
	Oct. 6	441	414	.....	27	.....	4	.....	23	3	.....
		462	434	93.93	28	6.07	4	.....	24	4	.....
B	Aug. 23	3	2	.....	1	.....	.....	.....	1	1	.....
	Sept. 12	5	3	.....	2	.....	.....	.....	2	2	.....
	Oct. 6	362	347	.....	15	.....	.....	.....	15	4	.....
		370	352	95.14	18	4.86	.....	.....	18	7	.....
C	Aug. 23	2	1	.....	1	.....	.....	.....	1	1	.....
	Sept. 12	9	8	.....	1	.....	.....	.....	1	.....	.....
	Oct. 6	218	215	.....	3	.....	1	.....	2	.....	.....
		229	224	97.81	5	2.19	1	.....	4	1	.....
D	Aug. 23	12	7	.....	5	.....	.....	.....	5	5	.....
	Sept. 12	14	12	.....	2	.....	.....	.....	2	2	.....
	Oct. 6	954	941	.....	13	.....	1	.....	12	4	.....
		980	960	97.95	20	2.05	1	.....	19	11	.....
E	Aug. 23	7	5	.....	2	.....	.....	.....	2	2	.....
	Sept. 12	4	4	.....	.....	.....	.....	.....	.....	.....	.....
	Oct. 6	365	358	.....	7	.....	.....	.....	7	4	....
		376	367	97.60	9	2.40	.....	.....	9	6	.....
F	Aug. 23	2	2	.....	.....	.....	.....	.....	.....	.....	....
	Sept. 12	27	24	.....	3	.....	.....	1	2	2	.....
	Oct. 6	400	393	.....	7	.....	.....	.....	7	2	....
		429	419	97.67	10	2.33	.....	1	9	4	.....
	Grand total	2846	2756	96.84	90	3.16	6	1	83	33	....

Series 1, check trees

TREE	DATE	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT						
			Total	%	Total	%	End wormy	End and side wormy	Side wormy	Exit hole 1	Exit hole 2
X	Aug. 23	68	10	.....	58	.....	30	20	8	35	13
	Sept. 12	17	.....	.....	17	.....	9	4	3	9	.....
	Oct. 6	36	4	.....	32	.....	4	15	13	19	
		19	82	.....	37	.....	20	14	3	18	5
		240	96	40	144	60	63	53	27	81	18
Y	Aug. 23	88	6	.....	82	.....	42	25	15	60	7
	Sept. 12	53	3	.....	50	.....	20	19	11	36	4
	Oct. 6	75	1	.....	74	.....	10	51	13	43	7
		255	96	.....	159	.....	51	92	16	78	4
	Grand total	471	106	22.5	365	77.5	123	187	55	217	22

Average for X-Y.....28.41.....72.59

A study of the above tables discloses several very interesting facts. In plot 1 there is not a very wide variation in the fruitage, the number of apples ranging from 114 in tree B to 627 in tree D. The percentage of sound fruit varies from 85.38 per cent in tree E, with its 171 apples, to 92.98 per cent in tree D, having a maximum yield of 627 apples. Note that tree B had only 9 wormy fruit, nearly 8 per cent of the 114 produced, while the most wormy apples were found on trees C and D, each with 44 and forming, respectively, 9.93 and 7.02 per cent of the total product. Here, at least, the percentage comparison is obviously unfair, since the two trees had, as nearly as we can determine, a practically uniform infestation, yet the percentage varies considerably, due simply to the larger crop on one tree. There were no end wormy only on tree A, while the maximum in this classification was 5 on tree C. The side wormy range from 40 in tree D to 8 in tree B. It is perhaps significant that 8.6 per cent of the total fruit in this plot was side wormy, 7.5 per cent of this being side wormy only.

Plot 2 with its second poisoned application produced approximately 6 per cent additional sound fruit. This is nearly half a barrel, or 171 apples. It is probable that the somewhat greater yield of this plot, namely 2846 as compared with the 1839 of plot 1, had its influence in the production of a somewhat larger percentage of sound fruit. It is interesting to note certain details. The minimum tree C, with only 229 apples, produced 97.81 per cent of sound fruit, while the maximum tree D, with 980 apples, yielded 97.95 per cent of sound fruit, a difference of only .06 per cent. Here again we see the obvious injustice of a strictly percentage comparison, since C yielded only 5 wormy apples while D had 20, or, in other words, supported four times as many codling moth larvae, yet, owing to the disparity in fruiting, the percentage was practically identical. The minimum percentage of sound fruit was 93.93 produced by tree A yielding 462 apples, 28 of which were wormy. The minimum number of wormy apples, five, was produced by tree C mentioned above. The number of end wormy only ranges, among the individual trees, from nothing to 4, a total of 6 for the plot, with only 1 end and side wormy. It will be seen at once that only a little over 3.3 per cent of the apples in this plot were either side or end and side wormy, or a reduction in the

number of side or end and side wormy of nearly 6.3 per cent from that of plot 1, by far the greater number being side wormy only. The gain following this second application is apparent in the almost total elimination of end wormy fruit and the material reduction in the side wormy, the actual number being nearly one-half that in plot 1.

The two check trees, X and Y, yielding respectively, 240 and 471 apples, a total of 711, 72.59 per cent being wormy, give an excellent idea of the conditions which would have prevailed had there been no application of poison. They produced respectively, only 40 per cent and 22.5 per cent of sound fruit and totals of 144 and 365 wormy apples, 80 of these on X and 242 on Y, or 33 per cent and 51 per cent respectively, of the total yield being side wormy. There were only 28.41 per cent of sound fruit on the two trees. It will be seen that under natural conditions, such as obtained last year, approximately equal numbers were end and side wormy.

Series 2. This series of three plots and two check trees was laid out in the young orchard of Mr C. R. Shons at Washingtonville. These trees are about 18 years old, 16 or 18 feet high, thrifty, rather thickly set and with a steep incline just southeast of the experimental area. The three plots and the check trees, as will be seen by reference to figure 2, were all in the same row of trees, running approximately northeasterly and consisted so far as the experimental trees were concerned, with but one exception, of Baldwins. The two check trees were farthest from the highway. The experimental trees in this series, as in the preceding, were carefully selected so as to obtain, as far as possible, uniformity in fruitage and infestation. Plots 1 and 2 were thoroughly sprayed May 11th with arsenate of lead and bordeaux mixture. The first tank of 150 gallons contained 6 pounds of arsenate of lead (15–16 per cent arsenic oxide). This was applied to the actual experimental trees and the barrier trees, spraying them together with a few trees on the northeast corner of plot 2. The second tank contained 6 pounds of arsenate of lead and was put on the remaining barrier trees on the north side of plots 1 and 2 and also on a portion of the barrier trees on the southeast corner of plot 2. The remainder of the barrier trees, namely, those on the southwest corner of plot 2 and the southern ones on plot 1, were sprayed with 2 pounds of arsenate of lead and 1 pound of paris green to 150 gallons, in con-

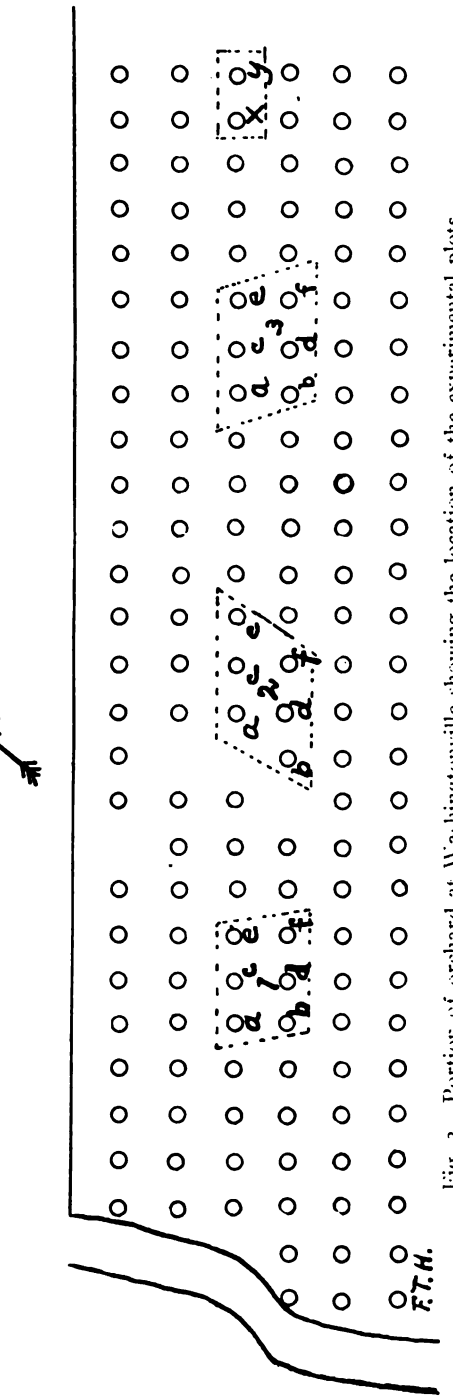

Fig. 2 Portion of orchard at Washingtonville showing the location of the experimental plots

nection with the bordeaux mixture. This latter consisted approximately of eight pounds of copper sulfate with enough lime to satisfy the copper, to 150 gallons.

The day was lowery with an occasional sprinkling of rain, but at no time did enough water fall to materially affect the work. The pressure was uniformly maintained at 85 to 100 pounds, a one horse gasolene engine supplying the power. Friend nozzles were employed, set at an angle and on the end of long extension nozzles, one man standing in a wagon, thus being able to throw the spray down upon even the highest blossoms. The actual experimental trees and the barriers separating them were Baldwins, while the two rows of barrier trees on the northwest were Wagners, and the same was true of the first barrier row on the southeast, the second being Baldwins. The blossoms had just dropped from the trees and the time of application was therefore nearly ideal.

Plot 2 was sprayed a second time June 1st and plot 3 for the first time on the same date. The day was cloudy with an occasional mistiness which did not interfere with the work, as there was not at any time enough moisture to wet the foliage. Six pounds of arsenate of lead (15 per cent arsenic oxide) was used to each 50 gallons of water and approximately the same formula as given above for the bordeaux mixture. 375 gallons of spray were applied to the 85 trees, it being sufficient to cause dripping in almost every instance. There was at this time no evidence of codling moth work, aside from possibly one apple which may have been entered at the side. Larvae of the green-striped apple worm, Xylina antennata Walk. and also those of a Tortricid, were rather abundant. The latter hid between the leaves and ate them as well as contiguous fruit. Apples were picked up under the experimental trees and classified August 24th, September 13th and October 4th–5th.

An examination of this orchard June 30th showed that the conditions were not so satisfactory as at Arlington. There was considerable bordeaux injury, especially on the plots receiving the early application. The poison was very evident on all the experimental trees. Those of plot 3, sprayed only on June 1st, showed less bordeaux injury than the others. The fruitage on some of the trees was disappointing, since many of the blossoms failed to set. Work of the Tortricid leaf roller, mentioned above, and the green fruit worm was quite evident.

An examination October 4th and 5th revealed much injury from the bordeaux mixture, many of the apples checking and codling moth larvae of the second brood entering at such points. An effort was made to approximate this injury and small, random samples from various trees were carefully sorted. The results are tabulated as follows:

Tree	1A	26 smooth,	48	injured
	1B	12 "	31	"
	1C	30 "	25	"
	2C	3 "	30	"
	2D	4 "	32	"
	2F	19 "	19	"
	3A	12 "	18	"
	3B	12 "	25	"
	3D	10 "	29	"
	X	77 "	23	"

We endeavored, in the above table, to put in the smooth class only those apples which were at least fairly smooth. A large proportion of those classed as injured were not seriously affected, aside from appearance, though some were badly gnarled and even cracked. It will be seen at once that a very high percentage of the fruit on all the sprayed trees were more or less rusted, while the proportions are approximately reversed on the unsprayed trees. Burning by bordeaux mixture was strikingly illustrated in Mr Shons' Ben Davis, some 90 to 95 and possibly 99 per cent of the apples being badly rusted and in some cases so seriously affected (pl. 13) that portions of the apple were irregular and more or less covered with rounded, tuberclelike elevations.

A considerable number of apples had been entered at the stem. The Tortricid larva, mentioned above, was still working on the apples in some numbers, either under a leaf, on the side of the fruit or beneath a light web at the blossom end. A note made by Mr Young September 13th records that over 90 of the 115 clean apples dropped from tree E, plot 3, had been gnawed by some larvae, probably that of this Tortricid. The work of this insect is illustrated on plates 10 and 11. A tabulation of the data obtained upon these plots follows.

Series 2, plot 1

TREE	DATE	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT						
			Total	%	Total	%	End wormy	End and side wormy	Side wormy	Exit hole 1	Exit hole 2
A	Aug. 24	65	36	.....	29	.....	1	1	27	23	1
	Sept. 13	42	18	.....	24	.....	.....	1	23	14	.....
	Oct. 4-5	310	180	.....	130	.....	11	1	118	40	.....
	Oct. 18-19	249	168	.....	81	.....	12	2	67	17	.....
		1262	1226	.....	36	.....	4	.....	32	.....	.....
		1928	1628	84.44	300	15.56	28	5	267	94	1
B	Aug. 24	43	28	.....	15	.....	.....	1	14	11	.....
	Sept. 13	52	33	.....	19	.....	1	.....	18	12	1
	Oct. 4-5	391	182	.....	209	.....	27	5	177	81	.....
	Oct. 18-19	259	168	.....	91	.....	18	.....	73	7	.....
		911	880	.....	31	.....	8	1	22	.....	.....
		1656	1291	77.96	365	22.04	54	7	304	111	1
C	Aug. 24	77	43	.....	34	.....	1	.....	33	25	.....
	Sept. 13	83	58	.....	25	.....	3	.....	22	20	1
	Oct. 4-5	257	156	.....	101	.....	9	.....	92	38	.....
	Oct. 18-19	102	77	.....	25	.....	4	.....	21	2	.....
		578	568	.....	10	.....	1	.....	9	.....	.....
		1097	902	82.22	195	17.78	18	.....	177	85	1
D	Aug. 24	60	38	.....	22	.....	1	.....	21	16	.....
	Sept. 13	48	33	.....	15	.....	.....	.....	15	13	.....
	Oct. 4-5	185	85	.....	100	.....	9	5	86	30	.....
	Oct. 18-19	183	118	.....	65	.....	11	2	52	19	.....
		602	585	.....	17	.....	1	.....	16	2	.....
		1078	859	79.68	219	20.32	22	7	190	80	.....
E	Aug. 24	59	44	.....	15	.....	1	4	10	10	.....
	Sept. 13	35	26	.....	9	.....	2	.....	7	6	.....
L	Oct. 4-5	279	158	.....	121	.....	5	.....	116	40	.....
	Oct. 18-19	217	161	.....	56	.....	8	1	47	.....	.....
		902	887	.....	15	.....	3	.....	12	1	.....
		1492	1276	85.52	216	14.48	19	5	192	57	.....
F	Aug. 24	33	16	.....	17	.....	.....	.....	17	13	.....
	Sept. 13	37	25	.....	12	.....	.....	.....	12	7	.....
	Oct. 4-5	152	84	.....	68	.....	8	2	58	36	.....
	Oct. 18-19	133	81	.....	52	.....	9	1	42	2	.....
		529	515	.....	14	.....	2	.....	12	.....	.....
		884	721	80.43	163	19.57	19	3	141	58	.....
	Grand total	8135	6677	82.08	1458	17.92	160	27	1271	485	3

Series 2, plot 2

TREE	DATE	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT						
			Total	%	Total	%	End wormy	End and side wormy	Side wormy	Exit hole 1	Exit hole 2
A	Aug. 24	70	51	.....	19	.....	1	1	17	17	.....
	Sept. 13	49	39	.....	10	.....	.....	.....	10	6	.....
	Oct. 4–5	273	132	.....	141	.....	4	.....	137	41	.....
	Oct. 18–19	126	86	.....	40	.....	11	.....	29	9	.....
		583	572	.....	11	.....	3	.....	8	.....	.....
		1101	880	79.93	221	20.07	19	1	201	73	.....
B	Sept. 13	227	127	.....	100	.....	12	.....	88	65	.....
	Oct. 4–5	442	335	.....	107	.....	33	.....	74	31	.....
	Oct. 18–19	284	217	.....	67	.....	13	.....	54	7	.....
		1305	1284	.....	21	.....	4	.....	17	2	.....
		2258	1963	86.94	295	13.06	62	.....	233	105	.....
C	Aug. 24	38	25	.....	13	.....	2	1	10	9	.....
	Sept. 13	55	31	.....	24	.....	.....	1	23	11	.....
	Oct. 4–5	226	131	.....	95	.....	1	.....	94	25	1
	Oct. 18–19	127	85	.....	42	.....	1	1	40	6	.....
		685	675	.....	10	.....	.....	.....	10	.....	.....
		1131	947	83.73	184	16.27	4	3	177	51	1
D	Aug. 24	25	18	.....	7	.....	.....	.....	7	4	.....
	Sept. 13	69	49	.....	20	.....	2	1	17	14	1
	Oct. 4–5	192	105	.....	87	.....	3	.....	84	22	2
	Oct. 18–19	182	122	.....	60	.....	7	1	52	14	.....
		480	473	.....	7	.....	1	.....	6	1	.....
		948	767	80.90	181	19.10	13	2	166	55	3
E	Aug. 24	8	2	.....	6	.....	.....	.....	6	6	.....
	Sept. 13	7	5	.....	2	.....	1	.....	1	1	.....
	Oct. 4–5	27	17	.....	10	.....	.....	.....	10	2	1
	Oct. 18–19	30	23	.....	7	.....	1	.....	6	1	.....
		62	59	.....	3	.....	1	.....	2	1	.....
		134	106	79.09	28	20.91	3	.....	25	11	1
F	Aug. 24	96	64	.....	32	.....	2	.....	30	24	.....
	Sept. 13	103	69	.....	34	.....	4	1	29	14	.....
	Oct. 4–5	376	214	.....	162	.....	13	2	147	30	.....
	Oct. 18–19	196	136	.....	60	.....	4	1	55	16	.....
		973	959	.....	14	.....	3	.....	11	2	.....
		1744	1442	82.68	302	17.32	26	4	272	86	.....
	Grand total	7316	6105	83.45	1211	16.55	127	10	1074	581	5

Series 2, plot 3

TREE	DATE	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT						
			Total	%	Total	%	End wormy	End and side wormy	Side wormy	Exit hole 1	Exit hole 2
A	Aug. 24.....	183	60	.....	123	.....	46	7	70	64	5
	Sept. 13.....	170	77	.....	93	.....	51	7	35	31	.....
	Oct. 4–5.....	537	140	.....	397	.....	162	58	177	79	2
	Oct. 18–19.....	219	84	.....	135	.....	71	9	55	8	.....
		371	308	.....	63	.....	33	4	26	4	.....
		1480	669	45.20	811	54.80	363	85	363	186	7
B	Aug. 24.....	184	79	.....	105	.....	30	9	66	70	2
	Sept. 13.....	113	62	.....	51	.....	23	1	27	13	.....
	Oct. 4–5.....	429	124	.....	305	.....	140	35	130	69	9
	Oct. 18–19.....	213	104	.....	109	.....	65	5	39	15	.....
		565	546	.....	19	.....	12	.....	7	.....	.....
		1504	915	60.84	589	39.16	270	50	269	167	11
C	Aug. 24.....	52	14	.....	38	.....	26	1	11	21	1
	Sept. 13.....	42	4	.....	38	.....	24	6	8	12	.....
	Oct. 4–5.....	115	24	.....	91	.....	50	14	27	19	.....
	Oct. 18–19.....	46	18	.....	28	.....	19	2	7	4	.....
		60	54	.....	6	.....	6	.....	.....	.....	.....
		315	114	36.19	201	63.81	125	23	53	56	1
D	Aug. 24.....	151	50	.....	101	.....	39	3	59	44	3
	Sept. 13.....	143	60	.....	83	.....	40	8	35	30	.....
	Oct. 4–5.....	456	156	.....	300	.....	111	29	160	86	4
	Oct. 18–19.....	185	84	.....	101	.....	56	3	42	15	.....
		773	746	.....	27	.....	17	.....	10	2	.....
		1708	1096	64.17	612	35.83	263	43	306	177	7
E	Aug. 24.....	229	115	.....	114	.....	65	1	48	60	2
	Sept. 13.....	164	39	.....	125	.....	46	37	42	44	1
	Oct. 4–5.....	527	127	.....	400	.....	196	35	169	94	3
	Oct. 18–19.....	197	66	.....	131	.....	70	22	39	32	.....
		433	401	.....	32	.....	13	11	8	5	.....
		1550	748	48.26	802	51.74	390	106	306	235	6
F	Aug. 24.....	87	49	.....	38	.....	16	1	21	21	1
	Sept. 13.....	37	27	.....	10	.....	5	.....	5	3	.....
	Oct. 4–5.....	138	86	.....	52	.....	8	5	39	16	.....
	Oct. 18–19.....	133	95	.....	38	.....	10	5	23	7	.....
		642	556	.....	86	.....	35	8	43	14	.....
		1037	813	78.39	224	21.61	74	19	131	61	1
	Grand total..	7594	4355	57.35	3239	42.65	1485	326	1428	882	33

Series 2, check trees

TREE	DATE	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT						
			Total	%	Total	%	End wormy	End and side wormy	Side wormy	Exit hole 1	Exit hole 2
X	Aug. 24.....	116	10	.....	106	.....	54	18	34	47	3
	Sept. 13.....	77	9	.....	68	.....	43	14	11	14	2
	Oct. 4–5.....	136	24	.....	112	.....	62	16	34	29	.....
	Oct. 18–19.....	50	22	.....	28	.....	14	6	8	2	1
		117	98	.....	19	.....	17	.....	2	3	.....
		496	163	32.86	333	67.14	190	54	89	95	6
Y	Aug. 24.....	227	22	.....	205	.....	70	83	52	89	6
	Sept. 13.....	106	23	.....	83	.....	52	7	24	19	.....
	Oct. 4–5.....	529	68	.....	461	.....	228	97	136	96	5
	Oct. 18–19.....	290	65	.....	225	.....	102	71	52	53	3
		352	252	.....	100	.....	58	12	30	20	.....
		1504	430	28.59	1074	71.41	510	270	294	277	14
	Grand total.....	2000	593	29.65	1407	70.35	700	324	383	372	20

This series, it will be seen by reference to the above tables, presents markedly different conditions in certain respects from those of series 1. There was a considerably larger setting of fruit, the totals for the three plots being remarkably uniform, and in addition there was a very serious infestation by codling moth. This was probably due in part, at least, to local conditions and it is possible that the sprayings were not quite so thorough as those in series 1. The entire equipment was different and it is by no means easy to make exact comparisons. An earnest attempt was made to secure the most thorough work possible under the conditions. It is very likely that a portion of the discrepancy in percentages may be due to the difference in varieties in series 1 and 2. Data upon this point is given in the case of two other varieties in series 3.

A study of the data given under plot 1 shows that the minimum tree F produced 884 apples, 80.43 per cent being sound, while the maximum tree B yielded 1656 apples and but 77.96 per cent free from worms. The maximum percentage of sound fruit, namely 85.52 per cent, was produced by tree E with its total of 1492 apples, while the minimum percentage of sound fruit, 77.96 per cent, contrary to the usual rule, was found on tree B mentioned above. The number of wormy fruit under individual trees ranged from 195 or 17.78 per cent on tree C to 365 or 22.04 per cent on tree B. In the case of the latter, we would call attention to the fact that practically all the wormy apples were on the ground by October 18th. The maximum number of side wormy or end and side wormy apples,

311 or nearly 19 per cent of the total, were found on tree B, less than .5 per cent of these being also end wormy. The minimum number of side or end and side wormy apples was found on tree F. This was 144 or 16.3 per cent of the total yield, less than .4 per cent being also end wormy. The entire plot produced 8135 apples, of which 1298, or 15.9 per cent, were side wormy or end and side wormy, the latter being a practically negligible quantity.

Plot 2 had the minimum yield of 134 on tree E, 79.09 per cent being sound. The maximum number of apples, 2258, was produced by tree B, which yielded 86.94 per cent of sound fruit. This tree also produced the maximum number, 295, of wormy fruit, amounting however, to but 13.06 per cent of the total yield. The smallest number of wormy apples, 28, was found on tree E, and constituted 20.91 per cent of the entire product. Percentage comparisons are very strongly in favor of B, though as an actual fact it bore ten times as many wormy apples. The maximum number of side wormy or end and side wormy apples, 276, occurred on tree F, and comprised 15.8 per cent of the entire product, less than 2 per cent of the whole yield being end wormy. The minimum number of side wormy apples, 25, were found on tree E and amounted to 18.6 per cent of the total yield, less than 2 per cent being end wormy. Here again we see the injustice of strictly percentage comparisons, since F had ten times as many wormy apples as E, yet the percentage of sound fruit is strongly against the latter. This plot as a whole produced 7316 apples, 1084 or 14.8 per cent being side wormy or end and side wormy. A comparison between plots 1 and 2 shows a gain in sound fruit from the second spraying of only 1.37 per cent, though there were 247 less wormy apples on plot 2 than on plot 1.

Plot 3 presents an entirely different set of conditions, since it was sprayed but once and then in early June. The minimum tree C yielded but 315 apples, only 36.19 per cent being sound. The maximum tree D produced 1708 apples, 64.17 per cent being free from worms. The wormy apples range in number from 811 in tree A to 201 in tree C, comprising 54.80 per cent and 63.81 per cent, respectively, of the entire product. The maximum number of end wormy or end and side wormy apples was found on tree A with its 448 thus classed, forming 30.2 per cent of the entire yield. The minimum number of 76 was produced by tree C and comprised 24.1 per cent of the total. The entire plot yielded 7594 apples, 1754 or 23 per cent of the total being side wormy. The plot as a whole yielded but 57.35 per cent of sound fruit, showing a marked discrepancy between it and the two preceding plots.

The two check trees produced 2000 apples, which is not far from a fair average as these trees ran, 1407 or 70.3 per cent of the total were wormy, 707 or 35.35 per cent being side or end and side wormy and 1044 or 51.2 per cent being end or end and side wormy.

Series 3. The young orchard of Mr William Hotaling of Kinderhook, was selected for certain corroborative experiments. The trees are exceptionally fine, only about five or six years old, dwarf in habit and, as a rule, heavily laden for such young trees. They are set in four rows running approximately north, with rows of peach trees between, and, in the case of the experimental areas, the Wealthy apples are alternated with Mackintosh. The actual experimental trees were on the 30th to 35th transverse rows north from the house and located on the two middle longitudinal rows. The check trees were similarly located on the 25th and 26th transverse rows. The data relating to the two varieties has been tabulated separately. The western row of the experimental trees was sprayed with arsenate of lead (15 per cent arsenic oxide) 3 pounds being used to a 44 gallon barrel, and a lime-sulfur solution, the latter composed of 1 gallon of a homemade concentrated wash testing about 35° on a Baumé scale to about 40 gallons. The eastern row of experimental trees received the same application, except that the bordeaux mixture, composed of 4 pounds of lime and 3 pounds of blue vitriol, was substituted for the lime-sulfur wash. The spraying was done May 17th, a hand pump with a rather fine Friend nozzle being employed. Care was exercised to see that the mixture was well stirred. The application was made by Mr Hotaling personally. He took special pains to cover the under, as well as the upper, surface of the leaves, being in this respect possibly a little more thorough than in his efforts to fill the upturned calyx ends of the young fruit. Almost every leaf was well coated and only a very little dripping was observed. It is possible, owing to the slight breeze, that the northeast side of the trees was not sprayed quite so thoroughly as other portions. The intervening peach trees were not sprayed. This orchard had been well sprayed the preceding two seasons.

The fruit was picked September 16th. It is probable that a large percentage, possibly 50 per cent, of the wormy fruit was attacked at points injured by a hailstorm which occurred May 30th. These places afforded almost ideal opportunities for the entrance of young codling moth larvae. The results are tabulated on page 30.

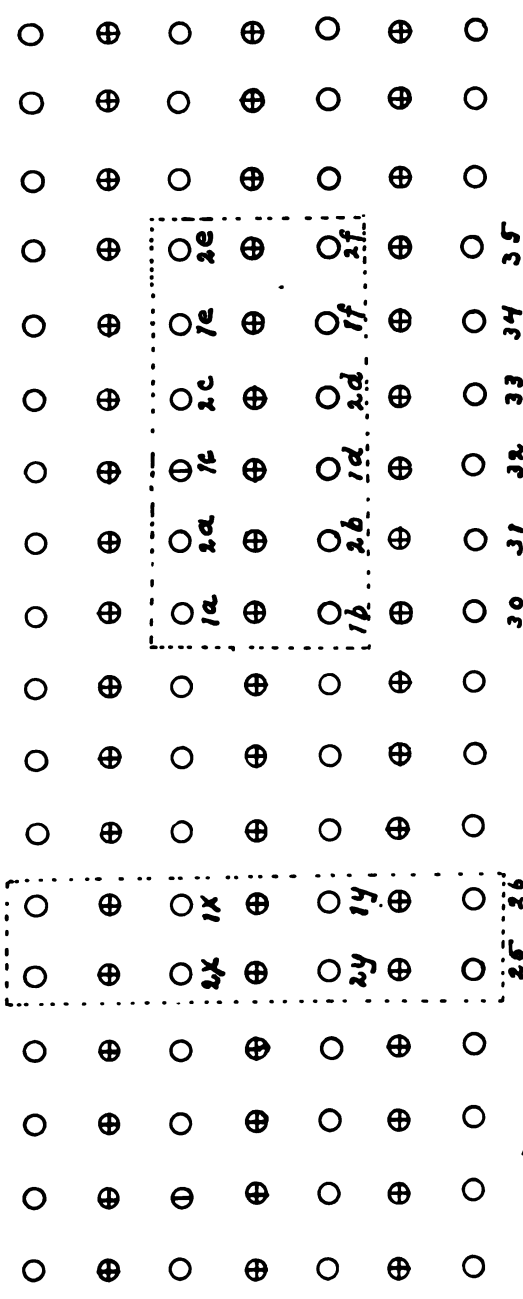

Fig. 3 Portion of orchard at Kinderhook, showing the location of the experimental trees

Series 3, Wealthy

TREES	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT						
		Total	%	Total	%	End wormy	End and side wormy	Side wormy	Exit hole 1	Exit hole 2
1A	106	84	79.25	22	20.75	3	.....	19	3	.....
1B	28	23	82.14	5	17.86	2	.....	3	.....	.....
1C	160	114	65.22	46	34.78	2	.....	44	7	.....
1D	81	51	62.97	30	37.03	1	.....	29	5	.....
1E	121	73	60.33	48	39.67	4	.....	44	8	.....
1F	33	26	78.79	7	21.21	.....	.....	7	.....	.....
Grand total	529	371	70.14	158	29.86	12	.....	146	23	.....
CHECK TREES										
1X	38	18	47.37	20	52.63	8	6	6	.....	.....
1Y	50	18	36.	32	64.	12	7	13	2	.....
Total	88	36	43.19	52	56.81	20	13	19	2	.....

Series 3, Mackintosh

TREES	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT						
		Total	%	Total	%	End wormy	End and side wormy	Side wormy	Exit hole 1	Exit hole 2
2A	179	110	61.46	69	38.55	8	2	59	16	.....
2B	16	8	50.	8	50.	1	.....	7	3	.....
2C	105	51	48.57	54	51.43	6	.....	48	6	.....
2D	87	27	31.04	60	68.96	9	2	49	10	.....
2E	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
2F	57	23	40.36	34	59.64	1	.....	33	9	.....
Grand total	444	219	49.33	225	50.67	25	4	196	44	.....
CHECK TREES										
2X	15	5	33.34	10	66.66	6	1	3	2	1
2Y	375	125	33.34	250	66.66	78	37	135	51	3
Total	390	130	33.34	260	66.66	84	38	138	53	

This series illustrates conditions where a minimum crop is produced. The maximum Wealthy tree C yielded but 160 apples, 65.22 per cent being sound, while the minimum B bore but 28, 82.14 per cent being free from worms. The maximum percentage, 79.25, of sound fruit was produced by tree A, yielding only 106 apples, while the minimum percentage, 60.33, occurred on tree E with its crop of 121 apples and its maximum number, 48, of wormy apples. The minimum number of wormy apples was 5, occurring on tree B and constituting 17.86 per cent of the total product, 11 per cent being side wormy. This plot produced only 529 apples, 70.14 per cent being sound, 27 per cent of the total side wormy, while only 2 per cent were end wormy.

The two check trees yielded 88 apples, only 43.19 per cent being sound and with the side and end wormy nearly equal in number.

The Mackintosh trees in this series show a greater degree of infestation, though they were interspersed with the others. The

maximum tree A produced 179 apples, 61.46 per cent being sound, and also the maximum number of wormy fruit, namely 69. The minimum tree B yielded only 16 apples, 50 per cent being sound, while the minimum per cent of sound fruit, 31.04, was found on tree D with its total of 87 apples. The minimum number of wormy apples occurred on tree B, 8, or one-half the total number being thus affected. Summarizing the data for this group of trees, it will be seen that only 49.33 per cent of the total yield of 444 were sound. A total of 45 per cent of the fruit was side wormy, while only about 6 per cent was end wormy.

The check trees produced a total of 390 apples, only 33.34 per cent being sound. 45 per cent were side wormy or end and side wormy, while 31 per cent were end wormy or end and side wormy, showing in this respect a marked difference from the fruit borne by the sprayed trees.

Summary of plots

SERIE	PLOT	TOTAL	CLEAN FRUIT		WORMY FRUIT						
			Total	%	Total	%	End wormy	End and side wormy	Side wormy	Exit hole 1	Exit hole 2
1	1.....	1839	1664	90.48	175	9.52	16	21	138	83	3
	2.....	2846	2756	96.84	90	3.16	6	1	83	33	.....
2	1.....	8135	6677	82.08	1458	17.92	160	27	1271	485	3
	2.....	7316	6105	83.45	1211	16.55	127	10	1074	581	5
	3.....	7594	4355	57.35	3239	42.65	1485	326	1428	882	33
3	Wealthy.....	529	371	70.14	158	29.86	12	.....	146	23	.....
	Mackintosh...	444	219	49.33	225	50.67	25	4	196	44	.....
1	Checks.....	711	202	28.41	509	71.59	186	240	82	298	40
2	Checks.....	2000	593	29.65	1407	70.35	700	324	383	372	20
3	Wealthy checks	88	36	43.19	50	56.81	20	13	19	2	.....
4	M'k't'h checks	390	130	33.34	260	66.66	84	38	138	53	4

A study of the above record shows almost the same percentage of infestation, namely 71.59 and 70.35 respectively, for the check trees in series 1 and 2. These two orchards were in the same general region and the results should therefore be approximately comparable. There is, however, a markedly higher percentage of side or end and side wormy in the checks of series 1, this totaling 322 and amounting to 45.28 per cent, while in series 2 the checks produced 707 side or end and side wormy, or but 35.35 per cent. The number of side wormy alone in these two checks is approximately proportional to the number of apples produced by the respective trees. These figures would indicate, in a general way at least, substantially identical conditions in the two series so far as infestation by the codling moth is concerned. A comparison of the percentage of wormy apples obtained on plots 1 and 2 in series 1 and those obtained on plots 1 and 2 in series 2, shows a marked and constant variation. Plot 1 series 1 produced 90.48 per cent of sound fruit, while the

similar plot in series 2 yielded only 82.08 per cent. Likewise, plot 2 in series 1 bore 96.84 per cent of sound fruit, number 2 of series 2 yielding only 83.45 per cent of worm-free fruit. It will be seen that there was a variation of from a little over 8 to over 13 per cent in favor of the plots in series 1. This may be explainable in part by the fact that the orchard in series 1 was younger and somewhat cleaner than in series 2, though it would seem as if some of this discrepancy must be attributed to less efficient spraying in series 2, especially as the experience of last year showed that an apparently minor factor, namely, a slightly less thorough spraying on one portion of a tree, resulted in reducing the amount of sound fruit by 2 to 3 per cent, and it is possible that a slight difference in the thoroughness of application, accentuated perhaps by the lack of an automatic mechanical agitator, was responsible for most of this discrepancy. There may also have been in the case of series 2 less thorough work on the trees adjacent to the experimental area than was the case in series 1. This was especially likely to occur on the trees lying on a steep hillside to the southeast of the experimental trees, where spraying could hardly be so thorough as in the comparatively level orchard where the experiments in series 1 were conducted. Allowance should also be made for the difference in varieties. Furthermore, the trees in this orchard were rather close together and this would be a great hindrance to the best work. It is interesting to compare the side or end and side wormy between these various plots. Plot 1, series 1, produced only 159, constituting some 8.64 per cent for the entire yield, while plot 1, series 2, yielded 1298 such fruit or 15.9 per cent of its entire product. Similarly, plot 2 of series 1 bore 84 side or end and side wormy, only 3.3 per cent of the entire yield, while plot 2, series 2, produced the relatively much larger number of 1084 or 14.8 per cent of the total number. Stated in another way, if we take the check trees as a standard, one application in plot 1 reduced the percentage of side or end and side wormy by 36.64 per cent, while a similar application to plot 1 in series 2 reduced this percentage only 19.45 per cent. Likewise, two applications in series 1 made a difference of 41.98 per cent of side or end and side wormy, while in plot 2 there was a difference in this respect of only 20.55 per cent. These figures all go to show that for some reason there was a decidedly lower efficiency in series 2 than in series 1.

Plot 3 of series 2 illustrates a totally different condition, since the one spraying was not given till about June 1st. We find a much lower percentage of sound fruit, namely 57.35, while the tree yielded

1754 side or end and side wormy apples, or 23 per cent of its entire product, or this one application, taking the check trees again as a standard, reduced the percentage of side or end and side wormy by only about 12 per cent. These figures give an excellent idea of the relative inefficiency of one application made at this season of the year.

A comparison of the totals in series 3 reveals an entirely different condition of affairs. The percentage of sound fruit was only 70.14 on the Wealthy and but 49.33 on the Mackintosh, the former variety yielding 146 side or end and side wormy, or 27 per cent of the entire product, while the latter produced 200 such apples or 45 per cent of the total yield. The checks in the Wealthy and Mackintosh respectively had 43.19 and 33.34 per cent of sound fruit, the former variety producing 32 side or end and side wormy, or 36.36 per cent, while the latter variety yielded 176 such apples, or 45 per cent. Again, taking the checks as a standard, it will be seen that, in the case of the Wealthy, one spraying reduced the wormy apples by 26.95 per cent, while on the Mackintosh the same treatment gave a reduction of only 15.99 per cent. The spraying of the Wealthy trees reduced the percentage of side and end and side wormy by about 9 per cent, while there was apparently no benefit in this respect on the Mackintosh. Percentage comparisons are certainly not very favorable when applied to small trees producing only 16 to a maximum of 375 apples, though they yield from only 5 to 69 wormy apples, a number smaller than that found on any trees in the other series where the percentages of sound fruit are much greater.

Tabulation of side wormy apples

SERIES	PLOT	NUMBER	%
1	1	159	8.64
	2	84	3.3
2	1	1 298	15.9
	2	1 084	14.8
	3	1 754	23.
3	Wealthy	146	27.
	Mackintosh	200	45.
	1 Check	322	45.28
	2 "	707	35.35
	3 "	.....	.....
	Wealthy check	32	36.36
	Mackintosh check	176	45.

Comparison of data with work of previous year. A comparison of the summarized figures given above with those obtained in 1909 shows that the codling moth was very much more abundant and

injurious last season. This is true of the check trees as well as of those which were sprayed. The check trees of last year produced as much sound fruit as some of the sprayed trees in 1910, though this is true only where very exceptional conditions prevailed. The percentage of wormy fruit was very much less than the present year, while the percentage of side and end and side wormy was even smaller, ranging in plots 1 to 6 in 1909 from less than 1 to 1.3 per cent. A similar condition obtained on the check trees, which produced 17.62 per cent of side or end and side wormy.

Conclusions. The data secured shows that it is possible with but one spraying to obtain over 90 per cent of sound fruit in a year when the codling moth is very abundant, even on trees yielding only 300 to 500 apples. A larger crop, as pointed out on preceding pages and in our discussion of the effects of maximum and minimum crops on the percentage of wormy fruit in 1909, would undoubtedly result in the production of a still greater proportion of sound fruit.

Second, we believe that the possibilities of one thorough timely spraying have habitually been underrated. The second application within a week or ten days after the blossoms drop, is practically a confession that the first spraying was not thorough. It is true that ideal conditions are rarely present and it not infrequently happens that spraying must be done even when working at a disadvantage. There are, therefore, times when a second spraying justifies itself, particularly if this is made about three weeks after the blossoms fall and at a time when the young apple worms are beginning to feed upon the foliage and search for a favorable point of entry upon the fruit.

Third, a later application would pay for itself under such conditions as obtained the past season, though the percentage of sound fruit might not be greatly augmented. Here we have an excellent opportunity for exercise of judgment. A large crop with indications showing only a moderate abundance of the codling moth should mean that in the great majority of cases one spraying would afford adequate protection. On the other hand, a small crop, especially if likely to be accompanied by high prices, would at least justify a second application.

Fourth, adverse conditions, such as crowded trees, steep slopes, inferior spraying outfits, etc., make thorough work difficult, and have an appreciable influence in increasing the percentage of wormy fruit, since thoroughness as well as timeliness is an important factor in controlling the pest.

Fifth, an adhesive poison, such as arsenate of lead, appears to be much more satisfactory, since it is not only fully as effective in checking the codling moth but appears to be extremely valuable in controlling such leaf feeders as the Tortricid observed upon the orchards in series 2. This insect and associated feeders are undoubtedly of importance in increasing the amount of wormy fruit.

Sixth, there are those who hold the single spray method to be of comparatively slight importance, even if nearly as efficient, because in many localities it is necessary, or has been considered necessary, to spray several times for the control of fungous diseases. Conditions in the Hudson valley are such as to hardly justify the repeated applications so generally in vogue in the western part of the State. Here, at least, we believe that a knowledge of the possibilities of one treatment will prove an important factor in encouraging thorough spraying and result in the more general production of sound fruit.

JUNIPER WEBWORM

Dichomeris marginellus Fabr.

Twigs of Irish juniper infested by a reddish brown, white-striped larva about one-quarter of an inch long were received February 28, 1910, from Mr S. G. Harris, Tarrytown. These active larvae webbed the needles together and it was found later that they throve almost as well upon the partially dried foliage as though it were in a succulent condition. A larger amount of material was kindly sent by Mr Harris in March and the species was also received through the State Department of Agriculture from Mr L. D. Rhind, Plandome, L. I. A fine series of moths was reared in late May and early June. These were provisionally identified as the above named species, the determination being confirmed by Mr August Busck of the United States National Museum.

This European species does not appear to have been previously discovered in America. Its distribution, as given by Dr H. Rebel, is Europe, except the polar regions and Siberia. A number of English localities are indicated by Meyrick in his British Lepidoptera. This beautiful imported species, easily recognized by its yellowish brown, broadly white-margined fore wings, will hardly become a serious pest, since its food plant is of very little commercial importance.

Life history. The active larvae are gregarious, spin a rather copious web and apparently thrive upon the dead or dying foliage almost as well, if not better, than upon the more healthy tissues. The transformation to the pupa occurs within the webbed mass,

the beautiful moths appearing as stated above, the latter part of May or early in June. It is possible that there is more than one generation annually.

Description. *Adult.* Length 7mm., wing spread 15mm. Tongue brownish yellow, slender, length 4mm. Palpi porrect, compressed, about 2.5 mm. long, thickly scaled, the outer and apical portions dark brown, the dorsal part creamy white; near the middle there is a slender, light brown pencil, fuscous apically, nearly as long as the palp and extending dorsally. Antennae long, slender, finely serrate, sparsely scaled. Eyes black. The vertex crowned with a spreading mass of long, creamy white scales. Thorax creamy yellow, margined laterally and anteriorly with fulvous brown scales. Fore wings long, narrow, fulvous brown, anteriorly and posteriorly broadly white-margined, these markings disappearing just before the apex of the wing; the fringe on the apical portion of the fore wing a mottled grayish and dark brown; hind wings satiny white, the fringe long, delicate, the under surface of both wings a nearly uniform pearl-gray. Abdomen yellowish brown, the fifth, sixth and seventh segments slightly darker and apically with a tuft of long, brownish yellow scales. Legs mostly reddish bronze.

Pupa. Length 5.5 mm., rather slender, reddish brown, the wing and antennal cases dark brown and extending to the fourth and fifth abdominal segments, respectively, the latter reddish brown, margined posteriorly with light reddish brown, sparsely setose; terminal segment subacute, narrowly rounded, with a cluster of five or six irregular, long, slender, hooked spines.

Larva. Length 6 mm. Head dark reddish brown with sparse setae. Antennae yellowish brown, short; thoracic shield broad, a variable dark brown, setose. Body light brown, the segments distinct and longitudinally striped as follows: median stripe reddish brown, submedian stripes whitish, sublateral dark brown, the lateral stripes light reddish brown, all somewhat broken. Setae with a length about half the diameter of the body, light brown; tubercles small, brown; thoracic legs dark brown, prolegs yellowish white, apically light brown; anal plate reddish brown, the middle paler, posterior margin dark brown, sparsely setose.

Bibliography. The following are a few of the more accessible publications relating to this species. For additional citations the reader is referred to Rebel (1901).

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1895 **Meyrick, Edward.** Hndb. Brit. Lepid. p. 607, 608 (Ypsolophus).
1901 **Rebel, H.** Cat. Lepid. Palaearc. Faun. 2:159 (Nothris).
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LARGE APHID SPRUCE GALL

Chermes cooleyi Gill.

Several specimens of this large gall on Colorado blue spruce were received July 22, 1910 through agents of the State Department of

Agriculture. At this time the galls were just opening and hosts of plant lice were issuing from their orifices. The aphids present a general resemblance to those of the more common spruce gall aphid, Chermes abietis Linn., though the galls themselves are easily distinguished by their greater size and especially their elongate character.

This new gall insect is a native of the Rocky mountain region and the Northwest, having been described in 1907 by Prof. C. P. Gillette, who states that he has observed this gall mostly upon blue spruce in Colorado from 4000 to 8000 feet altitude and chiefly upon Englemann's spruce above the 8000 foot line. He adds that he has seen specimens from the Northwest through the courtesy of both Drs Fletcher and Hopkins, and in each instance they were the typical galls of this new form. He finds this gall most numerous in parks or lawns where the blue spruce and the red fir are clustered together.

Description. The galls (pl. 17, fig. 1) are long, slender, terminal enlargements having a length of two inches or more and a diameter of approximately half an inch. According to Professor Gillette, they are always terminal and kill the end of the twig, except when the lice attack the bases of only a few needles on one side of the new growth, such being uncommon. Professor Gillette states that average galls have from 75 to 150 chambers, the lice from five large sized galls ranging in number from 463 to 996.

Aphids. The plant lice within the galls are light red in color with the bodies more or less covered with a white, waxy secretion which occurs both as a powder and as threads. (Gillette)

Stem mother. In winter or early spring grayish, about .6 mm. long by .3 mm. wide. Body almost black with a white secretion radiating as short, stout threads about the margins of the body and rising in a crest down the median line of the back. (Abstract from Gillette)

Adult viviparous female. Length 1 to 1.5 mm., width .8 to 1.2 mm., dark rusty brown, the dorsal surface mottled with dark spots, the wax glands which occur upon all segments but the last. Glands arranged as follows: A nearly continuous line on the anterior margin of the head and two patches on a side near the posterior margin, the thorax and abdominal segments with three glands on a side, but segments five to eight of the abdomen have the patches more or less united, especially in the dorsal rows, the other glands on the dorsum with pores quite uniform in size and rather small. Ventrally there is a pair of small patches upon the head behind the bases of the antennae and another pair of about the same size just in front of the middle coxae. Antennae very small, about as long as the femora of the fore legs; first and second segments short and stout, about equal; third nearly cylindric, nearly twice as long as segments one and two combined and with two tactile hairs apically.

Legs short, rather weak; tarsi biarticulate, the basal segment very short. (Abstract from Gillette)

Eggs. Length .3 mm., width .17 mm. They are light amber yellow at first, covered with a white powder. They are each attached by a thread, the whole mass adherent, an average sized one with a diameter of 2 mm. (Abstract from Gillette)

Winged female. Bright shining, rufous at first but by the time the wings are expanded the eyes are black and a few hours later the head and mesothorax are black. The other portions gradually darken, the abdomen retaining the rusty color longest. The white secretion begins to show about an hour after the pupal skin is cast and the aphid soon flies away. Length 1.5 to 2 mm. Wings a little smoky with a large stigma that is slightly green and a yellow costal nerve. The median fore wing is about 2.5 mm. long or about 1.6 times the length of the body with two simple discoidal veins and one stigmatal; hind wing with one discoidal vein, length of the hind wing about equaling the length of the body. Antennae dusky, with five segments, about ¾ as long as the greatest transverse diameter of the head; segments one and two short, stout, cylindric, about equal in length, segment one smooth, the others with impressed, transverse lines or wrinkles; segments three to five subequal, with segment three a little stouter and more conical; segments four and five rather slender, not especially enlarged apically nor swollen for the transverse sensoria, of which there is one to each of the three terminal segments, the fifth with two short hairs apically. (Abstract from Gillette)

Life history. The small, hibernating form of this aphid winters upon the twigs of its host plant with its long setae thrust into crevices in the bark between the needles. The heavy winter skin is cast about the middle of April and in a day or two the white, waxy secretion indicates the location of the louse, which is invariably on the under side of the twig. The first eggs are deposited in Colorado the latter part of April and before the female has attained her maximum size. The white, waxy threads completely hide both the egg and the female; a mass contains 500 eggs. The earlier deposited eggs begin to hatch before the females have completed laying, a large number of young being observed the latter part of the month. The formation of the gall is evidently produced by the young plant lice locating at the base of the young needles. The galls develop with surprising rapidity and are due to the thickening and lateral enlargement of the bases of the needles together with a swelling of the stem. They become fully developed about the first of July and by the middle or the latter part of that month most of the lice escape, a condition paralleled by our observations in New York. This generation in Colorado flies to the red fir, establishes itself upon the leaves and begins

almost immediately to lay eggs which accumulate in large piles beneath the wings. Individuals of this generation may produce about 150 eggs. Occasionally a few specimens feed and oviposit upon the blue or silver spruce, though this is unusual. The aphids hatching from these eggs remain upon the red spruce throughout the winter and are probably the chief, though perhaps not the only, source of the variety coweni Gill. It is also considered probable that the stem mothers for the two summer broods of C. cooleyi Gill. come in a similar manner from the winged females of variety coweni Gill. of the red fir. (Abstract with additions from Gillette)

Remedial measures. It is probable that, as in the case of the spruce gall aphid, Chermes abietis Linn., thorough spraying of the infested trees in April with a whale oil soap solution, 1 pound to 2 gallons of water, would prove very effectual in checking this insect. The galls may also be cut off and burned in June, thus destroying the aphids before they have an opportunity to escape.

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ASH PSYLLA

Psyllopsis fraxinicola Först.

A number of small, yellowish or green, black-marked Psyllids, accompanied by badly curled ash leaves (pl. 15), were received from Rochester June 18, 1909. The insects were evidently very abundant and causing serious injury. The affected foliage was not only badly curled, but streaked here and there with purplish veins. The only other record of this European species in America appears to be that by Dr John B. Smith in his list of insects issued in 1899. He states that this Psyllid was imported from Europe and is quite injurious to ash trees. Dr L. O. Howard, through whose courtesy this species was determined, states that this form was found many years ago on the grounds of the Department of Agriculture, Washington, D. C. This species is reported as occurring all over Europe and, contrary to what we find in this country, the foliage is not deformed. It is about the same size as the widely distributed and much better known pear Psylla, Psylla pyricola Först, though easily distinguished therefrom by the white, tufted young, the lighter color and its occurrence upon ash.

Description. Length about 1/20 of an inch, yellowish or greenish and with yellowish or dark brown markings as follows: Submedian triangles on the pronotum; submedian and sublateral longitudinal stripes on the mesonotum and most of the metanotum. Antennae long, slender, yellowish or greenish, the first segment short, obconic, the second stout, cylindric, the third slender, fully three times the length of the second, the fourth less than ½ the length of the third and rather closely united with the somewhat longer fifth, the sixth, seventh, eighth and ninth, each subequal and about as long as the fifth, the tenth about ⅔ the length of the ninth, the eleventh reduced, ½ the length of the tenth and apically with stout spines, the ninth and tenth distally and the eleventh somewhat enlarged; eyes reddish. Fore wings mostly hyaline, variably fuscous along the anterior margin, near the distal third, in the region of the distal fourth and apically (pl. 16, fig. 1). The legs are a variable yellowish or green, the tarsi (pl. 16, fig. 6) being somewhat darker. The abdomen is yellowish or greenish with variable fuscous markings. The male of this species is remarkable because of the greatly developed genitalia projecting dorsally. The anterior organ is subtriangular and with a length about equal to half the width of the wing, while the posterior organ is irregularly subquadrate, stemmed and fuscous. A view of the extremity of the male abdomen is given on plate 16, figure 3. The female has somewhat the same general appearance as the opposite sex, being easily distinguished therefrom by the abdomen tapering to a subacute apex, bearing the ovipositor and secondary sexual organs (pl. 16, fig. 4).

The nymphs or young have the dorsum of the head mostly fuscous, the wing pads brown, the anterior abdominal segments greenish, the posterior fuscous and ornamented with a waxy secretion, the latter being produced at the lateral and posterior angles as long, waxy threads. The antennae are yellowish green, the basal and distal segments fuscous. The legs are yellowish green, the tarsi fuscous.

Life history. This species appears to have about the same life cycle as the pear Psylla, the adults wintering on the bark of the tree and the insects becoming abundant in June.

Control measures. It is probable that this pest could be controlled where circumstances warranted, by scraping the bark and spraying thoroughly in early spring with a contact insecticide, such as a lime-sulfur wash, a kerosene or petroleum emulsion, a strong whale oil soap solution or a tobacco extract for the purpose of destroying the hibernating Psyllids.

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NOTES FOR THE YEAR

The following are brief notices of some of the more injurious or interesting species which have been brought to our attention during the past year.

FRUIT INSECTS

Pear slug (Eriocampoides limacina Retz.). This insect very frequently occurs upon cherry and pear foliage in midsummer. The slug, only about one-half an inch long when full-grown is easily recognized by the slimy secretion covering an apparently olive colored or blackish, sluglike body, the anterior portion being distinctly enlarged. The work of this pest is very characteristic, since it skeletonizes the upper surface of the leaves more or less completely, the injured portion soon drying and turning brown. This species was unusually numerous the past summer in the vicinity of Kinderhook, N. Y., and extraordinarily abundant in the outskirts of Albion. The insect winters in the ground, the small, black, 4-winged, many veined sawflies, only about one-fifth of an inch long appearing in early spring and depositing their eggs singly in a slit through the upper surface of the leaf. The eggs hatch in about two weeks, the voracious slugs completing their growth in about twenty-five days. There are two generations, the larvae of the second usually being the more abundant and frequently occurring in numbers during July and early August.

It is comparatively easy to control this pest when necessary by spraying with a poison, since the somewhat sensitive slugs feed upon the upper surface and are therefore easily destroyed. One pound of arsenate of lead (15 per cent arsenic oxide) to 100 gallons of water would probably be sufficient, since paris green has been recommended at the rate of 1 pound to 250 gallons of water. The poison may also be applied dry or the slimy slugs destroyed by liberal, and if necessary, repeated applications of dry materials, such as air-slaked lime, land plaster, or even road dust.

Cigar case bearer (Coleophora fletcherella Fern.) Very few specimens of this destructive leaf miner were observed in apple orchards in the towns of Byron and Stafford, Genesee county, though it was quite abundant in some sections the preceding year and has been responsible, in part at least, for the practical destruction of several orchards. A serious infestation by this pest is likely to mean the loss of a crop, since the voracious

caterpillars, after wintering in their characteristic cigar-shaped cases attached at right angles to the twigs and nearly a quarter of an inch long, are very hungry and devour the young leaves and developing blossom buds with equal avidity. Very thorough early applications of a poison, using preferably arsenate of lead (15 per cent arsenic oxide) is advisable wherever this pest is numerous, though we have yet to find an orchard which has been well sprayed for several years, badly infested by this pest.

Cherry fruit fly (Rhagoletis cingulata Loew). This relatively new pest of the cherry grower has been somewhat abundant and injurious to Morello cherries in particular, at Germantown and vicinity. Mr S. E. Miller states that in 1909 the cherry crops of some five or six growers in that section were rather seriously affected by this maggot, though an investigation of local conditions in 1910 leads us to believe that in some instances at least, the injury may have been due in part to the plum curculio, Conotrachelus nenuphar Herbst. An examination of conditions June 29, 1910 in the orchard of Mr Miller showed that a few adult flies could be found upon each tree. There were no signs of oviposition, though the insects were frequently observed upon the fruit. We found a number of cherries infested by the curculio, though there was no evidence of the presence of maggots. Mr Miller was not certain but that the major portion of the serious injury of last year was due to curculio attack rather than to the work of the fruit fly. This year he sprayed with a poisoned lime-sulfur wash earlier in the season and the application was doubtless of service in controlling the plum curculio. Mr Miller, at our suggestion, had sprayed the trees with sweetened arsenate of lead (3 pounds of sugar and 4 ounces of arsenate of lead to 5 gallons of water) the previous week, probably the 23d. The mixture was dry and very evident upon the margins of the leaves, though none of the flies were observed working thereupon. There was no evidence of dead insects.

The orchard was visited on the afternoon of July 5th by Assistant State Entomologist Young. The day was sunny and very hot and comparatively few flies were then seen. The next morning flies were more in evidence, especially in certain portions of the orchard. They were taken in copula and a number of individuals captured. The insects became more active as the day advanced though oviposition was not observed. Some of the poisoned bait prepared by Mr Miller and described above, was sprinkled on a branch at 9.55 a. m. at what seemed a favorable place for the flies, and, although

there were numbers about the tree, it was five minutes before one alighted upon the sprinkled leaves. It appeared to feed and then walked about on the leaves and finally came to rest. It was observed for some thirty minutes moving about normally and then suddenly disappeared. A serious defect in the mixture is the rapidity with which it dries. It was found that individual flies could be captured by bringing the fingers near to the insect and then as it lit thereupon suddenly closing them. Subsequently it was found that the flies were attracted to the fingers probably because they were stained with cherry juice. This suggests that the poisoned bait mentioned above might be made more effective by the addition of some such flavor.

The evidence obtained the past season, while far from being as satisfactory as one would wish, is certainly not very promising so far as this poisoned bait is concerned. It is probable that our cherry growers will find a large measure of relief, if not practical immunity from injury, by picking cherries as soon as they are ripe and taking special pains to secure all the fruit, thus reducing the opportunities for the breeding of the flies and consequently lessening the danger of trouble the following season. We are inclined to believe that so far as this insect is concerned, prompt and thorough harvesting will afford a practical solution of the difficulty. Injury by plum curculio, an associate of the cherry fruit fly, can be controlled by persistent use of the beetle catcher or the employment of a poisoned mixture such as that used by Mr Miller the past season.

Lined red bug (Lygidea mendax Reut.).[1] Several years ago the late Professor Slingerland noticed briefly, as an apple insect, a small, red Hemipteron under the popular name of red bug (Heterocordylus malinus Reut). The form under discussion is very similar in appearance to the earlier described species, though easily separated therefrom by the much more prominent eyes and especially, as pointed out by our wellknown authority in this group, Mr E. P. Van Duzee, by the black line along the posterior margin of the pronotum.

The work of this new apple pest may be observed during May and early June on the three or four terminal, more tender leaves. These are more or less curled and frequently form partially inclosed retreats containing a brilliant red, partly grown bug. It is probable that this species injures the fruit as well as the red bug. The affected leaves have much the appearance of being injured by plant

[1] 1909 Acta Soc. Scient. Fenn., v. 26, no. 2, p. 47.

lice or aphids, though the ill-defined, brown spots suggest the possibility of their having been affected by sun scald or some obscure disease. The spotting of the tender leaves is somewhat the same as that on currant foliage, produced by the 4-lined leaf bug (Poecilocapsus lineatus Fabr.). Many tips were thus affected on the apple trees of Mr S. E. Miller of Germantown and the insect was somewhat abundant in the orchard of Mr C. R. Shons of Washingtonville, the nymph, presumably of this species, being taken in the last named orchard June 1st and three adults June 30th. The latter were secured only after repeated collecting, since the insects were by no means abundant. It is possible that some of the work described above is due to the operations of the red bug (Heterocordylus malinus Reut.) a species having similar habits.

These two forms resemble each other very closely and we take this opportunity to put on record their salient characteristics.

Lygidea mendax Reut. *Adult.* Length 6 mm., rather slender, the width 2 mm. The color varies from yellowish red to rather bright red and may be variably suffused with fuscous, this invariably forming a median stripe extending from the scutellum to the tip of the wing and including the membrane. Head dark red or yellowish red, the clypeus fuscous; rostrum extending to the posterior coxae, a variable fuscous yellowish, fuscous basally and apically. Eyes large, very protuberant, coarsely granulate. Antennae fuscous, hairy, first segment stout, with a length only half that of the greatly produced, slender second segment, the third segment slender, about half the length of the second, the fourth a little shorter than the third. Pronotum coarsely punctured, sparsely setose and margined posteriorly with a broad, black line, sometimes slightly broken mesially. Scutellum reddish or yellowish red, the posterior half, especially the submedian areas, a variable fuscous; the clavus, the internal angles of the wing, and the membrane mostly fuscous, forming a variable broad median stripe. Abdomen a variable red. Coxae red, trochanter and femora pale yellowish; tibiae fuscous yellowish or fuscous, the biarticulate tarsi a variable fuscous.

Partly grown nymph. Length 3 mm., width 2 mm., bright red, the tips of the wing pads a variable fuscous. Antennae yellowish fuscous. Legs mostly fuscous yellowish, the tibiae and tarsi slightly darker.

Heterocordylus malinus Reut. Length 6 mm., rather slender, width 2 mm., yellowish red or dark red with conspicuous fuscous markings and sparsely clothed with fine, whitish or yellowish white scales. Head triangular, mostly fuscous, the front sparsely clothed with small, whitish scales; rostrum a variable reddish brown and extending nearly to the posterior coxae. Antennae dark reddish brown, the first segment stout, length about ⅓ that of the greatly produced, more slender second segment, the slender third segment

about ½ the length of the second, the fourth shorter than the third, the apical ⅔ slightly dilated. Eyes rather prominent, coarsely granulate and reddish brown. Pronotum reddish brown, the anterior third fuscous, except the lateral angles, all sparsely clothed with small, white scales. Scutellum, the most of clavus and the membrane fuscous; the corium mostly red with a variable fuscous area in the middle and sparsely clothed with fine scales. Abdomen reddish brown; coxae, femora and tibiae mostly reddish brown, the tarsi somewhat fuscous.

This species is easily distinguished from the preceding by the fuscous area anteriorly on the pronotum, the absence of a fuscous margin posteriorly and by the fine, whitish scales on the head, thorax and wings.

Professor Crosby of the Cornell Agricultural Experiment Station finds a tobacco whale oil-soap solution applied just before blossoming to be an effective spray for use against the young red bugs.

Pear psylla (Psylla pyricola Först.). It will be recalled that the season of 1903 was remarkable for the excessive abundance of this jumping plant louse. It was so numerous then that pear trees with blackened, scanty foliage or almost none at all, were common sights during the summer, not only in the Hudson valley but also in central and western New York. Since then there has been comparatively little injury, at least of a general nature. Last season this pest was rather abundant in the pear orchard of James Clark at Milton. On July 21st there were numerous nymphs and some adults upon the trees and considerable honeydew, though this latter had disappeared largely following the rain of a few days earlier. There were very little or no Psylla to be seen upon the pear trees of Mr J. A. Hepworth near the river or upon those belonging to other growers in the immediate vicinity. Reports were received of serious injury by this pest in the central part of the State.

The experience of the past few years has shown that thorough spraying in early spring with a lime-sulfur wash, such as is used for the control of San José scale, is at least a powerful deterrent, if not a preventive of Psylla outbreaks. Mr J. R. Cornell of Newburgh believes that the efficacy of such treatment is materially increased by previously scraping the rough bark from the trees. This is undoubtedly true, and where orchards are liable to injury by this species we would advise careful scraping prior to the application of a lime-sulfur wash or a miscible oil. This should be followed in every instance by closely watching the trees during the summer. Should Psylla begin to be abundant it should be checked at once by thorough spraying with a kerosene or petroleum emul-

sion, a whale oil soap solution, or a tobacco preparation, making the application, if possible, just after a rain and using a coarse, forcible spray. The advantage of spraying just after a rain is that the moisture washes away in large measure the sticky excretion which protects the young Psyllas and thus renders them more susceptible to the application. A coarse spray is more effective than a fine, drifting fog because of its tendency to remove this protecting secretion.

San José scale (Aspidiotus perniciosus Comst.). The experience of the past year has but served to confirm the value of early and thorough applications of a lime-sulfur wash for the control of this pest. It is comparatively easy at the present time to find orchards which have been infested by San José scale for ten or fifteen years and yet show very few signs of its presence. This is due, in our opinion, to two factors. First, our methods of spraying have been gradually perfected so that the work of later years has been exceedingly thorough. Second, there has been a marked development in the preparation of the lime-sulfur washes, particularly in the commercial brands. There is no doubt as to the value of a well prepared homemade lime-sulfur wash, whether an excess of lime or a larger proportion of sulfur be employed. The formulas generally used till within the last year or two, usually called for a little more lime than sulfur. This preparation has demonstrated its effectiveness time and again and must still be regarded as an exceedingly valuable insecticide. Nevertheless, the so called concentrated lime-sulfur washes, distinguished from the earlier formulas by the use of approximately twice as much sulfur as lime by weight, have given exceedingly satisfactory results and possess several important advantages. This latter type of wash can be made up months in advance without danger of crystallization, provided freezing does not occur, and in a well made wash of this character there is practically no sediment. These two considerations are of great importance to the fruit grower who is frequently pushed for time in early spring, when the spraying can be done to best advantage, and is therefore unwilling or unable to take time to prepare the wash while spraying operations are being conducted. It is perhaps needless to add that this lack of sediment greatly reduces the danger of clogging nozzles and consequent delay in operations. Experiments have shown that the clear concentrated lime-sulfur wash is as effective, or at least nearly so, in destroying the scale as the old type of wash with its large excess of lime and frequently considerable sediment. The one trouble with the use

of the clear mixture is the difficulty of doing thorough work, because when recently applied it can not be seen readily. This trouble can be obviated to a large extent by adding a little milk of lime to the diluted mixture, using it simply as a marker.

Certain reports have come to this office to the effect that the San José scale was becoming less abundant or even dying out in restricted localities here and there in the State. There are undoubtedly trees, and possibly orchards, where the scale has not thrived to any great extent in recent years, but we have yet to find substantial evidence showing this to be at all general. The scale appears to be most abundant upon vigorous trees, and while we would not state it as a general rule, we believe that in most instances freedom from infestation is correlated in large measure with reduced vitality and a consequently limited fruition.

Blister mite (Eriophyes pyri Nal.). This small pest, as shown by personal examination, is generally present in the orchards of Byron and Stafford, Genesee county, frequently being very abundant in those which have not been sprayed. This mite is widely distributed in the Hudson valley, though very rarely numerous enough to cause material injury. It was observed by the writer somewhat generally distributed in orchards at Clarksville, Albany county, and also very prevalent in the orchard of Mr Cecil Boudewyns at La Grangeville. There is no question as to the efficacy of early spring applications of a lime-sulfur wash or a miscible oil for the control of this pest. The general characteristics of its work and control methods have been discussed by the writer in Museum Bulletin 134, page 48.

GARDEN AND GRAIN INSECTS

Rose scale (Aulacaspis rosae Bouché). This insect is widely distributed in both Europe and America, occurring mostly upon rose, blackberry and raspberry bushes, particularly in sheltered locations. It is easily recognized by the thin, papery white, oval scale of the female only about one-sixteenth of an inch in diameter and with a small, yellowish patch, the protection of the immature stage, near its apex. The white male scale is easily recognized by its smaller size, the narrow three ridges and the small, yellowish particle at one extremity. The appearance of a blackberry cane rather badly infested by this insect is well shown in figure 4, while the female and male scale are represented much more enlarged in figure 5.

This rose pest is widely distributed in America, having been recorded from Florida and Louisiana northward to New York, and even from California. It is said to hibernate in an immature condition in the extreme south. Professor Comstock records the issuing of males, oviposition by females and hatching of eggs February 22d from material taken in Florida, while Professor Morgan states that young appear in Louisiana the last of March.

Fig. 4 Portion of blackberry cane enlarged and showing a rather bad infestation by the rose scale. Numerous female and male scales are represented.

Fig. 5 Male and female rose scales much more enlarged

The middle of May 1901, infested twigs were received from Concordville, Pa., on which were gravid females, eggs and issuing males. Dr John B. Smith states that this species may winter in New Jersey in any stage from egg to gravid females, while we have at hand specimens from Ballston Spa taken in November 1910, showing both gravid females and eggs and indicating that this species probably winters in this condition. Office records show

that this pest has been received from Cornwall-on-Hudson, Poughkeepsie, Hudson, Castleton, Ballston Spa, Cobleskill and Brighton near Rochester. Young were appearing in considerable numbers on the material received from Hudson in early June and the same was true of specimens from Cobleskill collected October 18th. This species begins to breed in New York State the latter part of May or in June and apparently produces young in greater or less numbers throughout the season, though Professor Smith believes that there are not more than three generations in New Jersey. Material collected in New York State showed the presence of several parasites, Arrhenophagus chionaspidis Aur., while Professor Toumy has reported the rearing of Aphelinus diaspidis How. from this species.

This pest, as was observed by Professor Smith, is very likely to be abundant in sheltered, shady situations, especially beside buildings. It can be controlled best by thorough spraying in the spring at the time the reddish young appear, with a whale oil soap solution, using about one pound to six or seven gallons of water and repeating the applications at intervals of a week or ten days, so long as the abundance of the pest appears to justify the treatment. A kerosene emulsion, the standard formula diluted with at least nine parts of water, should be equally effective.

Greenhouse leaf-tyer (Phlyctaenia rubigalis Guen.). The pale green, rather slender, black spotted caterpillars of this species were brought to our attention in October by John Dunbar, Assistant Superintendent of Parks, Rochester, N. Y. because of their feeding upon the underside of chrysanthemum leaves. He found that they also attacked geraniums and some other plants. Mr Dunbar attempted to control the species with applications of hellebore, nicotine and even by fumigation, using one ounce of cyanide of potassium to 5000 cubic feet of space without apparent results, though this last named treatment is an effective check upon the white fly.

This insect has been known in entomological literature by several names. It was first described by Guenee in 1854 as Scopula rubigalis, while other authors published descriptions of this form under the names of Botys oblunalis Led. and Botis harveyana Grote. This species has been assigned to other genera such as Margaritia, Pyrausta and Pionia. It has been frequently discussed under the name of Phlyctaenia ferrugalis Hübn., a nearly cosmopolitan, world-wide form distinct,

according to Hampson, from the species we are considering. This latter appears to be widely distributed in North America, having been recorded in localities from the Atlantic to the Pacific coast and from Keywest north into Canada. It appears in its northern distribution at least, to be preeminently a greenhouse species.

The reddish brown and indistinctly black marked moth has a wing spread of about three-fourths of an inch. The fore wings are a variable yellowish brown with indistinct, serrate, blackish lines and spots. The hind wings are grayish and mostly indistinctly marked, both wings being margined by a row of rather distinct black spots. When at rest the hind margins of the posterior wings touch and the moth has a flattened, triangular shape.

The full-grown caterpillar is about three-fourths of an inch long, green or greenish yellow in color and somewhat transluscent. The head is light amber with obscure, pale brown, irregular markings, the first thoracic segment usually with a subdorsal pair of small, black spots, or the cervical shield may be transparent. The remainder of the body has a broad, greenish white dorsal stripe extending to the subdorsal region, with the darker alimentary tract showing through. This stripe in some individuals is whitish transparent and margined by narrow, white, subdorsal lines. The sides are pale yellowish green. The tubercles are small, piliferous, semitransparent and shiny. Anal segment with a subdorsal pair of small, irregular, black spots. The true legs are yellowish transparent, the prolegs semitransparent.

This caterpillar is a very general feeder, having been recorded by various writers as attacking celery, cabbage, beets, tobacco, Ageratum, geranium, ground ivy, German and Kenilworth ivy, violet, heliotrope, wall flower, wandering Jew, dahlia, daisy, Justicea, chrysanthemum, carnation, Cineraria, begonia, abutilon, roses, anemone, nasturtium, moon vine, Swainsonia, Genista, Plumbago, Matricaria, Passiflora, Ruellia, Tydaea, Lobelia, Veronica, Lantana, Deutzia, nodding thistle (Carduus), Ambrosia, several species, and Sisymbrium.

These somewhat general feeders are most noticeable in secluded situations and display a marked preference for the terminal leaves, eating holes in the latter. They feed chiefly at night, resting by day in one location, a retreat in which the final transformations usually occur. The duration of the larval existence extends from about three to possibly five weeks, and that of the pupa from one to presumably two weeks. It will thus be seen that several genera-

tions annually may be produced in greenhouses, considerable depending upon the conditions.

The experience of others as well as that of Mr Dunbar, cited above, shows this insect to be quite resistant to insecticides, such as hellebore, tobacco extracts, or fumigation with hydrocyanic acid gas. It is very probable that judicious and early under-spraying with a poison, particularly arsenate of lead, would prove an important means of controlling this pest. Such treatment is, as a rule, objectionable in greenhouses because of the accompanying disfiguration of the foliage.

Systematic hand picking, in connection with other work and including the destruction of the moths when at rest in a greenhouse, is perhaps as effective as any control method. This should be supplemented by isolating infested plants wherever noted and taking special pains to destroy all the insects thereupon before they are returned to the benches. Prevention of infestation is by all means the most satisfactory, and we would urge the exercise of great care to see that greenhouses are stocked in the fall with plants uninfested by this pest. There is always the possibility of moths of this species entering ventilators or doors in early fall. A careful watch should be kept for such infestations and should they occur great care exercised to destroy the caterpillars before the pest becomes abundant enough to cause serious trouble later in the season.

An extended account of this species, with references to other literature is given by F. H. Chittenden in Bulletin 27, new series, Division of Entomology, United States Department of Agriculture, from which certain of the above statements have been taken.

Wheat wireworm (Agriotes mancus Say). This common wireworm is best known because of its depredations upon wheat, its injuries being particularly severe in the Middle States. Mr Purley Minturn of Locke forwarded specimens and reported under date of May 20, 1910 that this pest had been quite injurious to oat fields in his vicinity, entirely ruining some. He adds that all badly infested fields had been in meadow for five years or more and were sown to buckwheat last year and to oats this spring. This species has also been recorded as injuring corn and potatoes.

The slender, tapering, brownish, slightly hairy parent insects, instantly recognized as click beetles or snapping beetles, occur in June. They are of a dark, waxy, yellow color and not readily differentiated from other numerous, very similar allies. The destructive form or larva of this species may be easily distinguished

from other wireworms by the pointed posterior extremity and especially by the two dark brown or black pits on either side of the last segment and almost touching the preceding segment. These wireworms, when full grown, are from about one and one-fourth to one and one-half inches long, waxy, yellow, slender and hard. The parent insects presumably deposit their eggs near the roots of grasses and the young hatching therefrom require three years to complete the life cycle. The transformation to the delicate pupa occurs within an earthen cell in late summer or early fall, the beetles emerging the latter part of the following May or during June.

Owing to the hard, chitinous covering of the wireworms, they can not be readily destroyed by the application of insecticides of any kind. Their subterranean habits and preying upon field crops of comparatively small commercial value, also increase the difficulties of satisfactorily controlling the pests. Destructive wireworms are most likely to be abundant in sod, particularly that which has been seeded for some time, and it is therefore unwise to plant on badly infested sod crops liable to serious injury. Should the latter be necessary, something can be accomplished by plowing in early fall, since this process destroys the delicate pupae in their hibernating cells. Experiments have shown the practicability of killing the parent click or snapping beetles by the judicious use of poisoned baits, such as clover or lettuce dipped in strong paris green water. This can be done successfully only in midsummer, at the time the parent insects are abroad, and should be continued so long as numbers of beetles are attracted to the bait. Unfortunately, these measures are of no immediate service in a field badly infested by the pest. Prof. H. T. Fernald, as a result of certain experiments, provisionally recommends tarring corn and then placing the same in a bucket containing fine dust and paris green mixed in such proportions that the corn, after being shaken up in the bucket, shows a greenish color. Such corn feeds through a seeder without difficulty and in the experiments came up satisfactorily, while check rows were badly injured. Examinations later showed that the wireworms were present close to the seed but that they did not molest the seed itself, apparently being repelled by the application. It is by all means advisable, as pointed out above, to avoid trouble, if possible, by planting on land free from these pests those crops which can not be protected. A rotation of crops will do much to prevent this pest becoming unduly abundant, since it is primarily a grass-feeding species and requires some three years to complete its life cycle.

Harlequin cabbage bug (Murgantia histrionica Stal.). This insect, though well known as a common and injurious pest of cruciferous plants in the South, is rare in the northern states. Dr John B. Smith, in his list of Insects of New Jersey, published in 1899, reports its occasional presence in destructive numbers in southern New Jersey. We find on referring to our records, that in the report of this office for 1900 this species was reported from Elmira and Oswego, and Jamaica, L. I., the two latter localities being brought to our notice through the courtesy of Dr L. O. Howard. The past summer specimens of this bug were received from Mr Roy Latham at Orient Point, the extreme eastern end of Long Island. This latter record is interesting, showing the continued presence of the insect on Long Island and its extension over practically all of that section. It is hardly probable that this species will ever become abundant enough in New York State to cause material injury.

SHADE TREE INSECTS

Elm leaf beetle (Galerucella luteola Müll.). This pest continues to attract a great deal of notice on account of its serious depredations, especially in the Hudson valley. Numerous trees almost defoliated or with badly skeletonized leaves were rather common in the cities and villages of the valley from New York city northward to Stillwater and vicinity. A noteworthy feature was a report of serious injury accompanied by numerous specimens received from Mr Frank T. Clark of Ticonderoga. This appears to be the northermost record for the occurrence of these beetles in numbers in New York State. The injury by this pest was severe in the Mohawk valley at Schenectady and locally at Amsterdam. The elms of Ithaca, judging from reports received, have also been seriously injured.

The season of 1910 has been remarkable in the Hudson valley because of the prolonged drought following a scarcity of water the preceding season. This condition undoubtedly had an important influence upon the thrift of the trees, a fact easily demonstrated by examining elms where there were practically no elm leaf beetles. The foliage on many of these trees was thin and, though not skeletonized, was in a far from satisfactory condition. As a consequence, trees suffering from drought and exposed to a further depletion of energy through the attacks of a voracious leaf feeder, were more seriously affected than usual by this latter injury. Many trees will go into the winter with a reduced vitality, and it is to be

expected that considerable dead wood will be found another spring. All such trees should receive special attention next season. The dead wood should be removed and this possibly supplemented by judicious pruning, the exposed cut surfaces being protected from the weather by applications of tar, paint or similar materials.

Most important of all, these trees should also be protected from the continued ravages by the elm leaf beetle. Experience has demonstrated time and again the entire practicability of controlling this pest by thorough and timely applications of an arsenate of lead (15 per cent arsenic oxide) to the under surface of the foliage at about the time the leaves are three-quarter to full grown, something depending upon the number of trees to be treated. The most effectual spraying for this pest must be done between the middle of May and the 25th of June. It is practically useless to apply poison after the grubs commence to forsake the trees unless the foliage has been so thoroughly skeletonized that the majority of the leaves will drop and a new crop appear. Spraying for the protection of this new foliage is always justified by results, and the late applications may also be of service in protecting foliage which had escaped injury earlier in the season. There are three important factors to be observed in this work if one would secure satisfactory results; namely, timeliness, the securing of proper material and its thorough application to the under surface of the leaves. Inattention to any one of these details will result in unsatisfactory work, if not in a complete failure in the efficacy of the operations. Our modern high power spray apparatus makes it possible to treat such trees rapidly and without great expense. These methods, if carried out faithfully, should insure practical immunity from serious injury and enable the elms to regain some of their normal vigor. It is perhaps unnecessary to add that so far as the elm leaf beetle is concerned, the application of sticky bands to the trunks of the trees, or the scraping off of the rough bark, are of so little value as not to deserve serious consideration at the hands of the practical man.

Bag worm (Thyridopteryx ephemeraeformis Haw.). Numerous half grown larvae of this species were received June 3, 1910 from Mr M. C. Albright, who took them at New Baltimore. This, as has been previously pointed out, is near the northern limit of this species.

Sugar maple borer (Plagionotus speciosus Say). The presence of this pernicious borer at Fulton was recorded in our report for last year. An examination the present season

shows that the destructive work has continued without abatement, there being several centers of infestation. One is near the northwest corner of the park and is marked by a nearly dead maple tree having a trunk diameter of about 18 inches and showing approximately fifty of the characteristic exit holes, some of them being a year or more old. There has been a spread from this center of infestation upon either side and the existence of adjacent trees is threatened. Several similar centers were found on Cayuga street, namely, a row of four dead or dying magnificent trees between Second and Third streets, another on South Third street beside the church facing Cayuga street, and a fourth at the corner of Cayuga and Fourth streets. The above probably represents only a portion of the maples seriously affected by this pest. A complaint accompanied by specimens shows this insect to be destructive to the sugar maples at Carthage, and at Palmyra.

Elm scurfy scale (Chionaspis americana Johnson). This species is more or less abundant upon elms throughout the State. A very badly infested limb was brought in May 10, 1910 by Mr W. B. Landreth of Schenectady, with the statement that the tree, set some twenty years previously, and with a trunk diameter of about 15 inches, was in poor condition. Last year many of the young leaves dropped when they were partly out and another crop developed. The tree is said to be in a somewhat better condition this year, though apparently far from vigorous. Judging from the specimen submitted, this scale insect appears to be responsible for the major portion of the injury, since the twig is well spotted with scales and numerous crawling young are to be seen upon the bark.

False cottony maple scale (Phenacoccus aceri-cola King). There has been an unusual number of complaints concerning this insect, the majority coming from Mt Vernon and vicinity, though reports of injuries were received from Newburgh and Batavia. Personal observation showed that this pest was somewhat abundant on trees at Newburgh and, to a less extent, at Hopewell Junction.

This species is easily distinguished from the older and better known cottony maple scale[1] by the fact that it occurs in conspicuous felted masses upon the trunks of infested trees and also forms large, cottony aggregations on the foliage (fig. 6), two situations where the cottony maple scale is never found with its contrasting white covering.

[1] Pulvinaria vitis Linn.

The full-grown females of the false maple scale may be found on maple leaves in summer and are then about one-quarter of an inch in length and with a slightly less transverse diameter. The parent insects are concealed by an oval mass of powdery, slightly stringy wax within which is the female and her eggs (frequently 500 in number), the former occupying the anterior portion and her

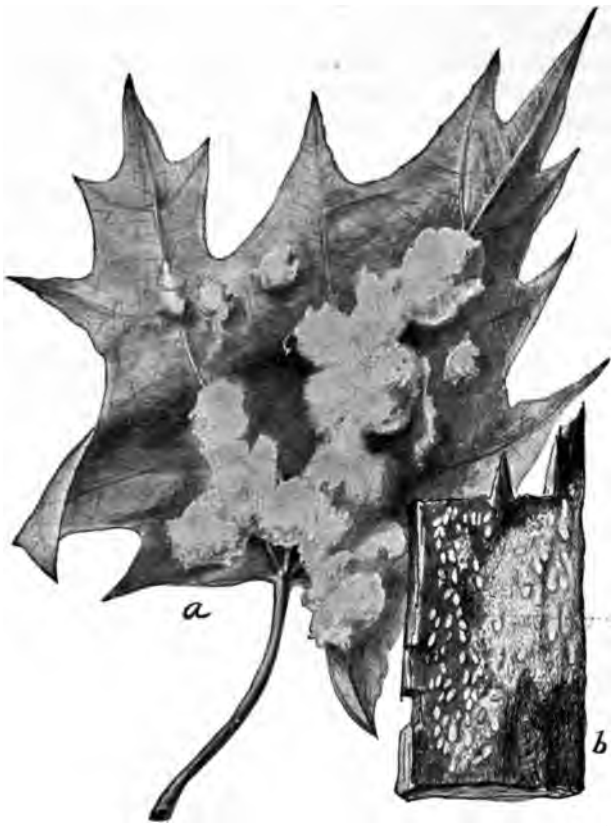

Fig. 6 False cottony maple scale. *a*=adult females on leaf; *b*=young females and males on bark. Natural size. (After Howard. Insect Life. 1894. 7:235)

body constituting about one-quarter the bulk of the mass. The young remain on the leaf after emerging from the eggs, unless it is too crowded, in which event they crawl down the petiole and seek nourishment on healthy foliage. The males, on attaining full growth, become restless and wander over the trunk and limbs for from seven to ten days, finally secreting themselves beneath or

upon the rougher outer bark, form the conspicuous felted masses frequently seen, and therein transform to pupae. There are probably three generations in this latitude, the winter being passed by the young in crevices of the larger limbs. Observations at Poughkeepsie last fall showed that crawling young were very numerous October 4th. Affected trees drop their foliage earlier in the fall while that of others is still green and at least moderately vigorous.

This scale insect can be controlled by thorough applications, in winter or early spring, of a contact insecticide, using 1 pound of whale oil soap to a gallon of water. The kerosene emulsion, the standard formula diluted with 4 parts of water, has been found very effective in controlling the cottony maple scale and would doubtless prove equally efficient in the case of this species. Several oil preparations now on the market under various trade names have also been employed successfully.

FOREST TREE INSECTS

Large black carpenter ant (Camponotus herculeanus Linn.). The work of this large wood ant is rather common in the Adirondacks where it appears to display a marked partiality for balsam trunks, excavating them in a very characteristic manner as illustrated and pointed out by the author several years ago.[1]

An examination of the balsam shows at once that the ants had eaten out the softer portions of the wood, and left in large measure the harder parts formed toward the end of the season when growth was comparatively slow and the wood correspondingly firmer. This style of galleries was also compared with the very irregular and markedly different work of this species in elm. The latter is undoubtedly due to the fact that the fibers of elm wood interlace and, as a consequence, there is very little difference in the relative hardness of the wood laid down at different seasons of the year. The past season we secured from Silas H. Paine of Silver Bay an exceptionally fine specimen of the work of this species in poplar. By reference to plates 19, 20, it will be seen that the method of excavation is somewhat intermediate between that obtaining in poplar and the elm and presumably explainable by the nearly uniform, soft texture of poplar wood. The general plan shows a series of horizontal chambers connected by numerous more or less regular, perpendicular galleries traversing the heartwood. Portions of the galleries strikingly suggest the ruins of an ancient castle. This ant

[1] 1905 N. Y. State Mus. Mem. 8, 1: 90, pl. 31.

occasionally establishes itself in houses and, if allowed to multiply unrestricted, may seriously weaken the timbers.

Abbott's pine sawfly (Lophyrus abbotii Leach). This rather common and occasionally destructive species was unusually abundant in the foothills of the Adirondacks last summer. This insect was reported as defoliating pines in August, by Mr Andrew Lackey of Johnsburgh and by Messrs Wesley Barnes and J. W. Wilson of Olmstedville. Mr Lackey stated that the insects had injured quite a number of his pines, while a personal examination showed that this sawfly was abundant on a comparatively few trees at Olmstedville, being restricted to some 40 or 50 pines in the creek bottom. One of these trees was nearly 50 feet high and so badly injured that practically all the foliage was destroyed, while at its base were to be found thousands of half-grown larvae unable to secure nourishment necessary to the attainment of their normal growth. Many cocoons were observed in the needles at the base of this tree August 9th and 10th. None appeared to be of normal size, since they were from one-third to even one-fourth smaller than cocoons made by larvae received early in August from Mr Lackey. The other affected pines at Olmstedville were all small, rarely more than 25 or 30 feet high and none of them were so badly injured as the one described above. In some instances there were numerous full-grown larvae, specimens of which were secured. It was also stated that this insect was at work on near-by pines, though a cursory examination revealed no evidence of their operations. There were signs here and there of pines being injured, presumably by this insect, along the line of the Delaware and Hudson Railroad running from Corinth to North Creek. Rev. G. H. Purdey reported under date of August 22d, similar injury here and there to pines in the vicinity of Warrensburgh. No adults developed last season from the cocoons collected in August. There appears to be but one generation annually.

The destructive caterpillars, when full-grown, are nearly an inch long and easily recognized by the black head and the yellowish white body ornamented with two rows of oblong, square, black spots down the back. On each side there is another row of about eleven black, nearly square spots, a little longer than broad. These false caterpillars, when disturbed, throw back the head and move the upper portion of the body in a manner very similar to that of caterpillars belonging to the genus Datana. The larvae spin their brownish, oval cocoons among the leaves. Dr Riley states that some of the

flies appear early in spring, while others do not issue till the latter part of June. One parasite, Limneria lophyri Riley, has been reared from this sawfly. This species may occur upon both white and hard pines from midsummer till late fall. The parent insects deposit their eggs in little slits in the leaves. They are rather stout, 4-winged sawflies, the common name being given because of the sawlike appendage at the tip of the female abdomen. This sex has a wing spread of about two-thirds of an inch, is honey-yellow, the head and thorax being a little darker, the latter and the abdomen being slightly marked with black. The male has a wing spread of about one-half of an inch, and the body is black, except the yellowish underside and the tip of the abdomen.

Experience has shown that this species is most likely to injure young pines, consequently it is well, where feasible, to watch for the appearance of the pests in such plantings and if circumstances warrant, adopt repressive measures. Many larvae can be jarred from small trees by vigorous shaking and their ascent prevented by an application to the trunk, of a sticky band such as tree tanglefoot. There is no doubt but that thorough spraying with a poison, preferably arsenate of lead (15 per cent arsenic oxide) would destroy these leaf feeders. It might pay to resort to such practices where only a few trees are badly infested, largely for the purpose of reducing the likelihood of more extended subsequent injury.

Spotted Cornus sawfly (Harpiphorus tarsatus Say). This greenish yellow, black spotted sawfly was received September last from Joseph H. Dodge of Rochester, through the State Department of Agriculture, accompanied by the statement that the larvae were very abundant and destructive to Cornus mascula. This sawfly appears to be a rather common form and widely distributed, since it has been recorded from Canada, Massachusetts, Connecticut, Indiana and West Virginia. The eggs, according to Dr Dyar, are deposited under the lower epidermis through a slit cut from above. They are close to the midrib in a long line, the cuts united. One edge of the swelling is on the midrib or large vein, the other parallel to it but wavy and composed of numerous saw cuts. The recently hatched larva is nearly colorless, with a slightly fuscous head. The latter becomes darker as development progresses and eventually black, while the body remains whitish or pale olivaceous, the black marks appearing in the sixth stage. The following description was drafted from full-grown living larvae:

Larva. Full-grown. Length 2.5 mm. General characters: head black, body greenish yellow with subdorsal and sublateral rows of black spots, venter orange-yellow.

Head subglobose, shining black, the single ocellus on each side, black. Antennae with the basal segment whitish transparent, the four distal segments with a yellowish tinge. Labrum yellowish; mandibles reddish basally, shining black apically; maxillary palpi, labium and labial palpi whitish transparent. Body segments 6 annulate dorsally, the first thoracic segment with the anterior two or three annulae mostly yellowish or yellowish orange; dorsum mostly yellowish green. The subdorsal row of black spots is composed of two on each segment, the anterior one extending over three annulae, the posterior on two, the first being approximately subquadrate, the second transverse and with a length nearly twice its width; the lateral row composed of large, irregular, quadrate spots, one to each segment and extending over four annulae. Anal plate with submedian, quadrate, black areas anteriorly and a median, quadrate, black area posteriorly, the remainder yellowish. Spiracles oval, brownish black, the subspiracular and ventral area orange-yellow; true legs pale yellowish, slightly fuscous apically; prolegs on abdominal segments 2 to 8 and 10.

The parent sawfly has been described by Norton[1] as follows:

Length, male, 0.32. Br. wings 0.52 inch. Length, female, 0.60. Br. wings 1.12 inch.

Female and male. Body long and stout; antennae longer than base of thorax, stout, flattened, serrate, black, with the four apical joints white; head as in E. varianus, with the sutures at sides of ocelli widened below and inclosing the base of antennae; nasus deeply incurved, rugose; labrum white, its edge rufous; tegulae piceous or yellow; scutel in middle white; legs black; all the trochanters, the apical half of four anterior tibiae and their tarsi and the posterior tarsi, except first joint, white (sometimes the first joint also). Wings smoky hyaline, base of stigma white; second recurrent nervure a little removed from intersection of second and third submarginals.

Blue Cornus sawfly (Harpiphorus versicolor Norton). Numerous specimens of these sawfly larvae were received from Dr L. F. Rinkle of Boonville, September 18th, accompanied by the statement that they had entirely stripped one bush of Cornus alternifolium. This sawfly appears to be less abundant than the preceding, having been recorded from Illinois and New Jersey. The eggs, according to Dr Dyar, about three in number, are laid side by side under the lower epidermis from above, forming a short row nearly parallel to a side vein. The young larva has a pale brown head and a curled, whitish body, the latter becoming well covered with a white, mealy secretion in the third stage. The following description of the full-grown larva was drafted from living specimens.

[1] 1867 Norton, Edward. Amer. Ent. Soc. Trans. 1:231.

Larva. Full grown. Length 2 cm. This species is most easily recognized by the black head and the mostly black, transversely blue-banded dorsum, the ventral surface being orange-yellow.

Head shining black, the one lateral ocellus brownish black. Antennae short, fuscous yellowish, ventral fourth of head mostly fuscous yellowish including the labrum. Mandibles brownish black apically; labium, maxillary and labial palpi fuscous yellowish. Body segments irregularly 6 annulate dorsally, the first thoracic segment with the anterior two or three annulae orange-yellow, the others with the first three and the fifth annulae shining black, the fourth being light blue dorsally and subdorsally, black laterally and the sixth light blue. Anal plate black and with a few short spines or hairs. Spiracles oval, brownish black, the subspiracular area and venter orange-yellow; true legs yellowish transparent, fuscous apically; prolegs on abdominal segments 1 to 7 and 10.

The parent insect has been described by Norton[1] as follows:

Length 0.40. Br. wings 0.80 inch.

Female. Body long and not very stout, color chestnut-red; antennae not longer than base of thorax, thick, serrate beneath, third joint but little longer than fourth, the two basal joints piceous, the three next black, remainder white; face as in E. varianus, not so much depressed below antennae; clypeus not deeply notched; a black spot from below antennae to summit; labrum and tegulae white; thorax black, scutel black, basal plates rufous, legs rufous, trochanters and tarsi white; coxae, basal tip of the four anterior femora and the apex of posterior tibiae blackish; wings smoky, base of stigma white; second recurrent nervure a little removed from junction of first and second submarginal cells.

Spotted pine weevil (Pissodes notatus Fabr.). Seedling pines shipped from Oudenbosch, Holland and submitted for examination April 13, 1910 through the State Department of Agriculture, had the terminal shoots infested by a number of active, though full-grown larvae of this species. Pupation occurred shortly thereafter and several adults were reared in early May. The operations of this European form were very similar to those of the common American white pine weevil, Pissodes strobi Peck, though in this instance at least, there was a marked difference in the life history, since this imported insect appears to winter as a larva.

This European species, kindly identified by Dr A. D. Hopkins of the United States Bureau of Entomology, is about one-third larger than our native Pissodes strobi Peck and is most easily distinguished therefrom by the indistinct ochreous red coloration and the smaller, more inconspicuous, whitish spots on the distal

[1] 1867 Norton, Edward. Amer. Ent. Soc. Trans. 1:230.

third of the wing covers. Dr Hopkins states that this weevil is a very important enemy of the pine in Europe, and that owing to the danger of its becoming a serious pest in this country, every precaution should be adopted to prevent its obtaining a foothold in America. In passing, we would call attention to the fact that Ratzeburg has recorded 29 species of parasitic Hymenoptera living at the expense of this weevil. Nevertheless, it would certainly be much safer to exclude seedling pines, particularly as there is also grave danger of importing a very destructive fungous disease.

Snow-white linden moth (Ennomos subsignarius Hübn.). This insect, which has come into prominence during the last three years on account of its extended depredations in the Catskills and, to a lesser extent, in the Adirondacks, was again abundant in at least limited sections of the Catskills. A number of eggs of this species were brought in March 28th by Mr Edward Thomson of Frost Valley, Denning, Ulster county, accompanied by the statement that they were numerous in his vicinity. Mr Edmund Platt of Poughkeepsie stated, under date of July 16th, that the caterpillars of what were undoubtedly this species, were very abundant just southeast of Shokan, also in Ulster county, at an elevation of about 2000 feet. The foliage was badly eaten and the caterpillars were observed hanging from the leaves in every direction. Evidently they had cut off many leaves, pieces of which were strewn on the ground. Beeches, maples, moosewood and apparently every variety of forest tree in that vicinity, were eaten. The caterpillars were so thick as to make it very disagreeable walking through the woods. There were a few at lower elevations and again near the top of the mountain. Miss Maud M. Meyer stated, under date of July 20th, that the maple trees in the vicinity of Bushnellsville, Greene county, were being destroyed by caterpillars, undoubtedly this species. A specimen of the moth was transmitted by Dr James C. Ayer of Glen Cove, under date of July 22d, this gentleman fearing it might be the much more dangerous brown tail moth. This report from Long Island shows that the insects were probably somewhat abundant there, while personal observation disclosed the fact that they were to be found in small numbers July 22d at Milton and Marlborough, and also on the electric cars at Hudson and near Valatie. Apparently this pest is less numerous than it was last year and it is to be hoped that natural enemies, birds in our estimation occupying a prominent place in this respect, will soon reduce their numbers so greatly as to prevent extensive injury in the future.

There should be no difficulty in distinguishing this species from the brown tail moth mentioned above. The parent insect is a rather slender-bodied, usually snow-white moth (pl. 21, fig. 2) having a wing spread of about one and one-half inches, the female being a little larger. It is decidedly more slender than the brown tail moth and the latter, though flying at about the same time, may be instantly recognized by the characteristic bright reddish brown tuft on the tip of its abdomen.

The eggs of the snow-white linden moth are deposited in irregular masses (pl. 21, fig. 1) about half an inch in diameter, each containing from 50 to over 100 eggs. The individual eggs lay at an oblique angle to the supporting surface, are about 1 mm. in length, barrel-shaped, light brown and with a conspicuous salmon-colored ring at the extremity.

The full-grown caterpillar has a length of about two inches. The head is a dull reddish or yellowish brown, distinctly broader anteriorly, the clypeus sunken, yellowish brown, the labrum pale yellowish with a few conspicuous yellowish setae, while the antennae are short, the basal segment yellowish, the second segment prolonged, reddish yellow, narrowly yellowish at the extremities and with a few coarse setae apically. The mandibles are reddish brown, fuscous apically and irregularly bidentate; labial palpi triarticulate, mostly pale yellowish; spinneret concolorous. The thoracic shield is darker than the head and distinctly fuscous along the margins. The body is mostly a dull brownish black, the anal plate and the anal prolegs being yellowish brown. There are irregular, yellowish markings along the sublateral lines, they being represented by inconspicuous dots on the second and third thoracic segments. These markings are so thick on the first abdominal segment of some specimens as to give the appearance of short sublateral lines extending most of the length of the segment. On the third abdominal segment the yellowish markings are distinctly produced laterally and toward the median line, forming a pair of submedian irregularly oval, yellowish marks very suggestive of tubercles. These sublateral marks are indicated on the remaining segments only by inconspicuous dots, a pair on the anterior and posterior annulets of each segment, the yellow markings becoming a little thicker and more irregular on the 11th, 12th and 13th segments.

The true legs are a variable yellowish and reddish brown, the distal segments being somewhat darker. The first pair of prolegs are dark brown basally and yellowish brown apically; the anal prolegs are mostly yellowish brown; the venter is nearly the same color

as the dorsum, except that part between the prolegs which is variable yellowish green and yellowish brown.

The pupae occur among the leaves, being sheltered in very light, thin, yellowish brown cocoons. The pupa is about one inch long, the general color being a yellowish brown irregularly spotted with black. The antennae, legs and wing sheaths are closely fused and extend to the tip of the fourth abdominal segment; the terminal segment is pale yellowish or yellowish straw; the cremaster is composed of an irregular group of four stout, dark brown, recurved hooks, two distal, two subapical and then two pair of more slender ones, the more distal being lateral and the others dorsal.

Control measures. This species, as stated before, is not an important shade tree pest, since the English sparrow can usually be relied upon to keep it within bounds. The control of this insect in woodlands is a much more serious problem and must depend in large measure upon natural enemies, such as parasites and especially our native insectivorous birds. These latter should be protected in every feasible manner.

Birch leaf skeletonizer (Bucculatrix canadensisella Chamb.). This small leaf feeder was generally abundant, though not exceptionally numerous, upon the white birches at Kinderhook. This occurrence is probably the western border of a severe outbreak in New England, recently recorded by William R. Thompson[1] and comprising areas in Connecticut, Massachusetts, New Hampshire and Maine, at least. Nine years ago this species was exceedingly numerous in the vicinity of Albany, skeletonizing practically all of the foliage of our ordinary white or gray birch, Betula populifolia. The full-grown caterpillar is only about one-fourth of an inch long, light green or yellowish green and most easily recognized in association with the peculiar, oval or circular, whitish, moulting cocoons about one-twelfth of an inch in diameter. The larvae may be found upon the trees in August or early September, feeding upon the soft parenchyma of the leaf and, when numerous, skeletonizing the foliage. The winter is passed in a narrow, brownish yellow, ribbed cocoon about one-fifth of an inch long. The parent moth is a delicate, bright brown insect with a wing expanse of three-eighths of an inch. The wings have two subtriangular blotches on the inner margin which, when these organs are closed, form two white dorsal saddles, while, in addition, there are three silvery white bars which run from the outer edge about half

[1] 1910 Journ. Econ. Ent. 3:436.

way across the wing obliquely toward the apex. Behind the anterior white saddle there is a tuft of raised, black scales and several similar ones at the apex of the fore wings. This species can hardly be considered as of much economic importance, since its food plant has very little commercial value.

Beech tree blight (Pemphigus imbricator Fitch). This rather common insect is easily recognized by the woolly plant lice or aphids occurring in masses on the under side of the limbs. This species is quite resistant to cold, since it was observed the latter part of October, 1903, after the temperature had been quite cold and while an inch of snow was to be seen on adjacent hillsides. It is a widely distributed species, having been reported from various parts of the State. It was undoubtedly this species which was reported by Dr D. B. Miller, Jersey City, N. J., under date of October 31st, as being abundant on the lower small branches of young beech trees in Delaware county. Mr George C. Wood, writing from the Trenton camp grounds at Barneveld, Oneida county, August 22d, stated that they were having a great deal of trouble with the insect, adding that every beech tree was covered with it and that it was fast killing the branches. Mr Frank A. Schmidt of Ilion, writing under date of September 14th, states that practically all of the beech trees in that vicinity were affected by this pest. The insects were so numerous that the lower branches of nearly all the beech trees were completely covered with the white, woolly aphids. These limbs seemed to have lost all vitality, since those half an inch in diameter could be bent and twisted like a piece of rope.

The great abundance of this insect over so large an area appears to be unusual for New York State. Owing to the fact that it occurs upon forest trees, active remedial masures are ordinarily impractical. We must depend in large measure upon natural enemies. One of the most important of these is the caterpillar of a native butterfly, Feniseca tarquinius Fabr. The mother insect deposits her eggs upon the twigs of beech, alder etc. in the midst of colonies of woolly aphids. The caterpillars, upon hatching, spin a thin web and devour many of the plant lice, completing their growth within thirteen days.

Silver fir aphid (Chermes piceae Ratz.). Nordmann's firs received from Europe the past season and submitted for examination by the State Department of Agriculture, were infested by a Chermes which was provisionally determined as the above named

species by Dr A. D. Hopkins of the United States Bureau of Entomology and the writer. An examination of the literature shows that there may be a question as to the specific identity of this European form. We have used the above specific name and given illustrations of the insect (pl. 18, figs. 1, 2), since our material was not sufficiently abundant to permit of an authoritative identification. This form may prove, as has been stated in the case of at least one Chermes on fir, to be a synonym of Chermes funitectus Dref.

Apparently, this is the first record of the introduction of the species into America. A Chermes discussed under this name by Gillanders is recorded by him as very destructive to young silver firs, comparatively young specimens of Abies nordmanniana and even fairly old trees of Abies nobilis. He states that young silver firs in nurseries are often killed outright by this insect. The data at hand justifies us in considering this species a dangerous form which should be excluded, if possible.

MISCELLANEOUS

Blow fly (Calliphora viridescens Desv.). Several larvae and two pupae of this species were received under date of July 30, 1910, from Mrs H. B. Reist of Schenectady, accompanied by the statement that they had been found under a rug in a study on the second floor of a new house. Subsequent correspondence developed the fact that the rug had been sent a month earlier to a vacuum cleaning establishment located over a stable. There appears to be no other probable explanation for the occurrence of the larvae in this strange environment, other than that they may have worked into the fabric from some adjacent nitrogenous material while at the cleaning establishment, since the common blow fly larvae, as is well known, thrive in fresh or decaying flesh, cheese or nitrogenous vegetables. The parent flies, kindly determined by Mr D. W. Coquillett of the United States National Museum, appeared August 10th. They are about one-third the size of the more common blow fly, Calliphora vomitoria Linn., with a somewhat similar steel-blue or violet-blue abdomen, though easily recognized by the grayish black thorax in marked contrast to the duller black thorax of C. vomitoria. It is perhaps needless to add that both of these blow flies are distinguished from the rather slender, grayish banded, exceedingly common house fly by their larger size, greater stoutness and violaceous coloring.

Stable fly (Muscina stabulans Fall.). This rather common fly was reared last May from larvae in bee comb found in association with a few small beetles which live in decaying animal matter. This record is not unprecedented, since, according to Dr Howard, this species has similar habits in Europe. The maggots of this fly usually occur in decaying vegetable matter, fungi etc., though they have been reported as living in cow dung, and Megnin records finding puparia in the mummified bodies of children. This species was captured at Washington several times on human excrement.

Saturnia pavonia Linn. One specimen of the dark reddish brown cocoon of this Bombycid was found on nursery stock at Rochester. The cocoon is 3.5 cm. in length, 2.5 cm. in diameter and with one end somewhat produced and partially open. The moth, which was easily reared, has a wing spread of 7.5 cm., is smaller than our well known Calosamia promethea Drury, and the coloring is mostly in shades of gray with distinct ocellate spots on both the anterior and posterior wings. There should be no difficulty in excluding this rather large species.

Insects and paper. Three years ago, through the courtesy of the A. T. de la Mare Printing & Publishing Company of New York, we received a large sheet of paper badly disfigured, though just from the calendering rolls. An examination showed that a May or June beetle had been caught in the heavy rolls and literally crushed into the paper, its body fluids making a smear some 12 inches long. A most interesting feature was the preservation of the hard parts, especially the legs and antennae, so perfectly that there was no difficulty in referring the victim to the genus Lachnosterna. An equally interesting specimen of this kind of work was discovered in a recent publication. The victim this time was a crane fly. The paper presented substantially (pl. 17, fig. 2) the same appearance as noted above, portions of the insect remaining even after the paper had been subsequently printed upon and bound. These accidents suggest the possibility of a novel ornamental card or sheet made by rolling into the paper the delicate wings of certain common insects, thus obtaining an effect impossible from purely artificial methods.

Agromyza melampyga H. Lw. Numerous specimens of this small, yellowish and black marked fly were reared the latter part of May 1910 from walking-leaf, Camptosorus rhizophyllus, collected at Hudson Falls May 16, 1910 by Stewart H. Burnham, assistant to the State Botanist. The infested leaves

presented a peculiar appearance at that time, since many of them were margined on the upper surface with a more or less linear series of equidistant, brownish elevations which, upon examination, proved to be the tips of the puparia. The larvae evidently live in communal mines and, when full-grown, cut a slitlike orifice and transform so as to leave the brownish bispinose apex of the puparia protruding from the orifice. A series of these presents an unique appearance. The puparium is about 2 mm. long, nearly 1 mm. wide, rather stout, a variable reddish brown, the exposed tip being a little darker. Apically there is a pair of dark brown, short, stout, chitinous, recurved processes. One parasite, kindly described through the courtesy of Dr L. O. Howard, by Mr J. C. Crawford as Sympiezus felti, was reared at the same time the flies issued.

The parent insect has been described[1] by C. W. Johnson under the name of A. flaviventris as follows:

Head light yellow, occiput black; antennae yellow, aristae black. Thorax light yellow, with a large black dorsal spot, which extends narrowly from the cervix, expanding dorsally, with lobes above the humeri and base of the wings; scutellum yellow, metatarsus black. Abdomen dull light yellow, terminal segment black; halteres and legs yellow. Wings grayish hyaline. Length of the larger specimen 2 mm.; the smaller one 1.5 mm.

These specimens were taken at Niagara Falls. It has been listed by Smith from New Jersey, recorded by Loew from the District of Columbia and identified from the Bahamas.[2] In addition this species has been reared at Washington, D. C., by Coquillett[3] from leaf mines in a species of cultivated Philadelphus and also from the common Plantain, Plantago major.

Coquebert's Otiocerus (Otiocerus coquebertii Kirby). The slender, yellowish or yellowish red marked insects belonging to this species and resembling somewhat in general appearance Caddis flies, are rather common and widely distributed, having been recorded from Canada, south to Texas and, in addition, from several Eastern and Middle States. The delicate adults have been taken upon a variety of trees, namely hickory, oak, beech, maple and also on grape.

This attractive insect belongs to the Hemipterous family Fulgoridae, noteworthy because of the large exotic lantern flies. The Brazilian Laternaria phosphorea has a wing spread of

[1] 1902 Can. Ent. 34:242.
[2] 1908 Psyche 15:80.
[3] 1898 U. S. Dep't Agric., Div. Ent., Bul. 10 n.s., p. 77.

fully 6 inches and an enormous miter-shaped head as long and nearly as thick as its body. The subfamily Derbidae to which Otiocerus is referable, is a group of moderate extent, comprising some of the most beautiful and delicate forms found in the Hemiptera. The head in this subfamily is generally produced forward, sometimes extremely compressed and with the sides prominently carinate as is the case with Otiocerus.

The adult of this species when at rest is nearly half an inch long to the wing tip (the length of the body is only three-sixteenths of an inch). It rests with the long, delicate wings folded together parallel and thus presents a general resemblance to a Caddis fly. It may vary in color from a nearly uniform, pale yellowish or yellowish green in the one female obtained to a yellowish green marked with strongly contrasting red or reddish brown in the males as follows: The broad stripe extends from the tip of the head on either side to the bronzy or blackish eyes, is continued by broken spots just below and behind these organs, and a larger, reddish area laterally on the pronotum and on the anterior portion of the mesonotum, and may be followed as an oblique stripe from the base of the fore wing to its posterior margin near the distal third, which latter is marked by a slight marginal fuscous line. From this point the reddish markings are produced in a more or less broken, marginal line to the anal angle, there being a small subapical branch near the distal fifth and a much more conspicuous one at the distal third and extending as an irregular, oblique mark to the anterior distal angle. There is, in addition, an irregular, reddish mark near the middle of the wing; the hind wings are nearly colorless. The head is strongly compressed, being greatly produced anteriorly and with strong lateral dorsal carinae. The male antennae are a variable reddish and remarkable, since each is composed of three irregular branches apparently arising from a basal segment, the anterior distinctly capitate. The antennae of the female are but two-branched, the anterior one slightly capitate and apically with a bristle nearly as long as the branch. The ovipositor is short, the organs uniting to form a conical apex. The legs are a nearly uniform yellowish transparent. The pale yellowish abdomen extends only to about the middle of the wings and is variously shaded with reddish. The male is easily recognized by the conspicuous pair of yellowish transparent, inflated, strongly curved clasping organs.

A colony of nymphs of this species were taken at Poughkeepsie, N. Y. May 12, 1910 under the dead bark of a stump, possibly beech. The insects moved slowly, and eleven days later adults emerged.

Nymph. Length one eighth of an inch, width about one-sixteenth of an inch. Color an obscure brown, the sutures yellowish brown; the head small, partially concealed by the prothorax; the wing pads short, extending to the third abdominal segment, each of the latter with a series of obscure tubercles, fuscous basally, lighter apically; along the anterior third the head and thorax apparently with similar though more rudimentary structures. Legs a yellowish brown.

It is remarkable that such an apparently large adult should develop from so small a nymph. A partial explanation is found in the fact that the abdomen of the adult is much shorter than one would be led to expect from the length of the wings.

PUBLICATIONS OF THE ENTOMOLOGIST

The following is a list of the principal publications of the Entomologist during the year 1910. Fifty are given with title[1], time of publication and a summary of the contents of each. Volume and page numbers are separated by a colon, the first superior figure gives the column and the second the exact place in the column in ninths: e. g. 75:9[15] means volume 75, page 9, column 1 in the fifth ninth, i. e. about one-half of the way down.

Grain Weevil. Country Gentleman, Jan. 6, 1910, 75:9[15]

A summary discussion of repressive measures.

Two New Cecidomyiidae. Entomological News, Jan. 1910, 21:10–12

Lasioptera tripsaci and Cecidomyia opuntiae described.

Deformed Apples. Country Gentleman, Jan. 27, 1910, 75:82[16]

A brief discussion of the work of the tarnished plant bug, Lygus pratensis Linn. The plant louse outbreak of 1909 is commented upon and control measures discussed.

Corn, Cutworms and Ants. Country Gentleman, Feb. 3, 1910, 75:107[25]

A brief discussion of methods for controlling various cutworms and ants in cornfields.

Scale and Fungus Attacks. Country Gentleman, Feb. 3, 1910, 75:107[33]

The San José scale, Aspidiotus perniciosus Comst. is identified and remedial measures briefly discussed.

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[1] Titles are given as published and in some instances they have been changed or supplied by the editors of the various papers.

Observations on the House Fly. Economic Entomology Journal, 1910, 3:24–26

Summary of experiments showing that the house fly, Musca domestica Linn. does not invade darkened apartments.

Some Tree Crickets. Country Gentleman, Feb. 24, 1910, 75:182[27]

Oecanthus niveus DeG. appears to be limited mostly to apple trees, while O. nigricornis Walk. and O. quadripunctatus Beutm. have been recorded as the species injurious to raspberry and blackberry bushes. Preventive measures are discussed.

Control of Flies and Other Household Insects. New York State Museum Bulletin 136, 1910, p. 1–53 (Issued Feb. 26, 1910, a revised and extended edition of Bulletin 129).

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Work with the Codling Moth. Country Gentleman, Mar. 3, 1910. 75:230[11]

A summary comparison of results obtained against codling moth, Carpocapsa pomonella Linn., between coarse and fine sprays and one, two and three applications. One thorough application of a mist spray gave 98–99 per cent of worm-free fruit.

Struggle with the Scale. New York Apple Orchards Saved. Rural New Yorker, Mar. 5, 1910, 69:256[11]

A summary account of the work against San José scale, Aspidiotus perniciosus Comst., with special reference to the success of Mr W. H. Hart in his old orchard.

Bleeding Elm — Beetle. Country Gentleman, Mar. 10, 1910, 75:245[42]

Discusses the causes of bleeding in trees and gives remedy for the elm leaf beetle, Galerucella luteola Müll.

The Apple Maggot. Country Gentleman, Mar. 17, 1910, 75:271[25]

A general discussion of Rhagoletis pomonella Walsh, with reference to work against fruit flies in South Africa with poisoned syrups.

Spraying for Codling Moth. Country Gentleman, Mar. 31, 1910, 75:322[27]

A summary discussion of remedial measures for Carpocapsa pomonella Linn., with special reference to results obtained with the single spray and with observations on prepared insecticides.

Schizomyia ipomoeae n. sp. Entomological News, April, 1910, 21:160–61

A description of this West Indian species reared from the flower buds of Ipomoea.

Methods of Controlling the House Fly and thus Preventing the Dissemination of Disease. New York Medical Journal, April 2, 1910, 91:685–87

A summary account of the house fly, Musca domestica Linn., with special reference to control measures.

Oyster-Shell Scale. Country Gentleman, April 7, 1910, 75:347[15]

Remedial measures for Lepidosaphes ulmi Linn.

Spraying for the Codling Moth. Economic Entomology Journal, 1910, 3:172–76

Summary of experiments for the control of Carpocapsa pomonella Linn., and emphasizing the effectiveness of one thorough application of poison.

Leopard Moth. Country Gentleman, April 21, 1910, 75:396[45]

Brief economic account of Zeuzera pyrina Fabr., with special reference to control measures.

Peach Twig Borer. Country Gentleman, May 12, 1910, 75:470[32]

Summary economic account of Anarsia lineatella Clem.

Borer. Country Gentleman, May 26, 1910, 75:517[26]

A brief discussion of the peach borer, Sanninoidea exitiosa Say and methods of controlling it.

Cutworms in the Garden. Country Gentleman, May 26, 1910, 75:518[36]

A discussion of remedial and preventive measures.

West Indian Cecidomyiidae. Entomological News, 1910, 21:268–70

Cecidomyia manihot on Cassava, Camptoneuromyia meridionalis from flower buds of Ipomoea are described as new. The larva of Schizomyia ipomoeae Felt is also characterized.

Maple Leaf Aphis. Country Gentleman, June 23, 1910, 75:603[14]

A brief general account of Pemphigus tessellata Fitch on maple.

Beet Leaf Miner. Country Gentleman, June 30, 1910, 75:622[85]

A summary economic account of Pegomya vicina Lintn.

Flies in the Stable. Country Gentleman, June 30, 1910, 75:628[11]

A general discussion of the house fly problem, Musca domestica Linn., with special reference to stables and methods of preventing breeding.

Onion Maggot. Country Gentleman, July 7, 1910, 75:642[17]

Remedies for Phorbia ceparum Meign. are briefly discussed.

Apple Tree Borer. Country Gentleman, July 7, 1910, 75:642[87]

Brief discussion of remedial measures for Saperda candida Fabr.

Green Fruit Worm. Country Gentleman, July 7, 1910, 75:646[47]

Records injuries by a green fruit worm, Xylina antennata Walk., in New York State.

Beans Hurt by Maggot. Country Gentleman, July 14, 1910, 75:660[11]

A summary account of Phorbia fusciceps Zett., with special reference to remedial measures.

Flea Beetle. Country Gentleman, July 21, 1910, 75:682[26]

A brief practical account of Epitrix cucumeris Harr.

Corn Worm. Country Gentleman, July 28, 1910, 75:703[18]

Control measures for Heliothis armiger Hubn. are briefly outlined.

Maple Scale. Country Gentleman, July 28, 1910, 75:703[17]

A summary discussion of the cottony maple scale, Pulvinaria vitis Linn., with mention of the woolly Phenacoccus acericola King and the alder and maple plant louse, Pemphigus tessellata Fitch.

Plant Lice. Country Gentleman, August 4, 1910, 75:722[24]

General directions for spraying for plant lice or Aphididae.

25th Report of the State Entomologist on the Injurious and Other Insects of the State of New York, 1909. Education Department Bulletin. N. Y. State Mus. Bul. 141, 1910, p. 1–178, 22 pl. (Issued August 4, 1910)

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Malaria and Mosquitos in New York State. Atti della Societa per gli studi della malaria, vol. 9, 1910, Separate p. 1–12

Summary discussion of malaria in New York, with a brief notice of the malaria-carrying species, their breeding places, enemies and legislation in relation thereto. A brief account is given of the mosquito control work in the State.

The Elm Leaf Beetle. Country Gentleman, Aug. 11, 1910, 75:740[25]

A record of injury with a summary discussion of remedial measures for Galerucella luteola Müll.

Recent Observations upon European Insects in America. Economic Entomology Journal, 1910, 3:340–43

Notes are given on Pissodes notatus Fabr., Dichromeris marginellus Fabr., Hyponomeuta malinella Zell., Saturnia pavonia Linn., Monarthropalpus buxi Lab. and Chermes piceae Ratz., all recently brought into this country.

Gall Midges of Aster, Carya, Quercus and Salix. Economic Entomology Journal, 1910, 3:347–56

A tabulation of the American species of Cecidomyiidae occurring upon the above named plants — 46 being recorded on willow. A new genus, Asteromyia, is erected and two new species, Oligotrophus salicifolius and Dasyneura corticis, described.

Scientific Notes. Economic Entomology Journal, 1910, 3:381

Galerucella luteola Müll is recorded from Fort Ticonderoga and serious injuries are reported throughout the Hudson valley. Observations are presented on the work and flight of the snow-white linden moth, Ennomos subsignarius Hübn.

Red Spider. Country Gentleman, Aug. 18, 1910, 75:762[36]

A discussion of injuries and remedial measures.

Melon Aphis. Country Gentleman, Aug. 18, 1910, 75:764[12]

Remedial measures for Aphis gossypii Glov. are given.

Tree Spraying. Country Gentleman, Aug. 25, 1910, 75:789[15]

Observations on methods employed by "tree-protecting companies" and those of service in controlling elm leaf beetle.

Scale on Maple. Country Gentleman, Aug. 25, 1910, 75:789[26]

Putnam's scale, Aspidiotus ancylus Putn. is identified and spraying with a lime-sulfur wash advised where the scale is abundant.

Vermin in the House. Country Gentleman, Aug. 25, 1910, 75:800[21]

The bed bug, Cimex lectularius Linn. is briefly described and exterminative measures fully discussed.

Asparagus Beetles. Country Gentleman, Sept. 8, 1910, 75:840[24]

Arsenical applications, preferably arsenate of lead, are recommended for the control of both species of asparagus beetles, Criocerus asparagi Linn. and C. duodecimpunctata Linn.

Tulip Scale. Country Gentleman, Sept. 8, 1910, 75:840[32]

Spraying with contact insecticides in early September to destroy the young of Eulecanium tulipiferae Cook is advised.

Harvest Mites. Country Gentleman, Sept. 8, 1910, 75:840[37]

The life history of this pest is briefly sketched and methods of avoiding infestation and allaying the irritation following an attack given.

Woolly Aphis. Country Gentleman, Sept. 8, 1910, 75:840[42]

Remedial measures are given for the woolly aphis, Schizoneura lanigera Hausm. and also for the scurfy scale, Chionaspis furfura Fitch.

Horticulture: Diseases and Pests. New York State Education Department. Review of Legislation, 1907–8. Legislation 391, p. 119–22 (Issued Sept. 1910)

A review of legislation for the years 1907 and 1908.

The Leopard Moth. Country Gentleman, Sept. 29, 1910, 75:922[21]

This insect, Zeuzera pyrina Fabr. and its work is described and control measures summarized.

ADDITIONS TO COLLECTIONS, OCT. 16, 1909–OCT. 15, 1910

The following is a list of the more important additions to the collections:

DONATION

Hymenoptera

Thalessa atrata Fabr., black long sting, adult on maple, June 13, S. W. Stillwell, Charlotteville

T. lunator Fabr., lunate long sting, adult, July 23, A. L. Kampfer, Albany

Aulacidea tumidus Bass., gall on Lactuca, August 30, Roy Latham, Orient Point

Neuroterus batatus Fitch, galls on white oak, July 8, J. H. Dodge, Rochester. Through State Department of Agriculture

Lophyrus abbotii Leach, Abbott's sawfly, larvae on pine, August 3, Andrew Lackey, Johnsburg. Same, from J. W. Wilson, Olmstedville

L. ? lecontei Fitch, Leconte's pine sawfly, larvae on pine, October 20, Townsend Cox, jr, Setauket

Trichiocampus viminalis Fall., poplar sawfly on poplar, August 29, H. S. Post, Albany

Eriocampoides limacina Retz., cherry and pear slug, larvae on cherry, August 22, L. A. Rose, Rensselaer

Harpiphorus tarsatus Say, sawfly, larvae on Cornus mascula, September 15, J. H. Dodge, Rochester. Through State Department of Agriculture

H. versicolor Nort., sawfly, larvae on Cornus alternifolium, September 18, L. F. Rinkle, Boonville

Coleoptera

Entimus imperialis Forster, diamond beetle, adult, May 7, Richard Lohrmann, Herkimer

Calandra granaria Linn., granary weevil, adults in grain bins, December 27, P. A. Schaefer, Allentown, Pa.

Magdalis ? barbita Say, black elm snout beetle, grubs on elm, March 18, S. L. Frey, Palatine Bridge

Pissodes strobi Peck, white pine weevil, larvae on pine, July 13, Benjamin Dorrance, Dorranceton, Pa. Through Hermann Von Schrenk

Phloeodes diabolicus Lec., adult on Polyporus growing on Eucalyptus, March 20, Hermann Von Schrenk, Southern California

Bruchus obtectus Say, bean weevil, adults, March 21, F. A. Fitch, Randolph

Haltica ignita Ill., strawberry flea beetle, adults on Virginia creeper, August 3, Miss L. E. Clarke, Canandaigua

Galerucella luteola Müll., elm leaf beetle, larvae and pupae on elm, July 19, F. T. Clark, Ticonderoga

Melasoma scripta Fabr., cottonwood leaf beetle on poplar, September 7, Theodore Foulk, Flushing. Through State Department of Agriculture

Centrodera decolorata Harr., adults on locust, October 18, Mrs J. De P. Lynch, Barneveld

Desmocerus palliatus Forst., cloaked knotty horn, adults on elder, June 6, H. T. Brown, Rochester

Elaphidion villosum Fabr., maple and oak twig pruner, work on oak, July 31, W. A. Payne, Bronxville

Prionus laticollis Dru., broad-necked Prionus, adult, July 18, Burton Ellison, Poughkeepsie

Xyloryctes satyrus Fabr., rhinoceros beetle, August 1, D. T. Marshall, Hollis

Euphoria inda Linn., bumble flower beetle, adult, September 6, J. D. Keating, Fort Edward

Cotalpa lanigera Linn., goldsmith beetle, adult, April 15, J. R. Gillett, Kingston

Thanasimus rufipes Brahm, adult, July 29, L. H. Joutel, New York (European)

Podabrus rugosulus Lec., adults, June 16, H. B. Filer, Buffalo

Agriotes mancus Say, wheat wireworm, larvae on oats, May 20, Purley Minturn, Locke

Diptera

Calliphora viridescens Desv., larvae, July 30, Mrs H. G. Reist, Schenectady

Bombyliomyia abrupta Wied., adult, July 26, H. E. A. Dick, Rochester

Rhyphus fenestralis Scop., adults, April 24, G. C. Hodges, New Hartford

Bibio xanthopus Wied., adult, May 18, Richard Lohrmann, Herkimer

Contarinia johnsoni Sling., grape blossom midge, adult, May 28, Fred Johnson, North East, Pa.

Monarthropalpus buxi Lab., pupae on box, May 19, A. E. Stene, Kingston, R. I.

Joanissia aurantiaca Kieff., Aprionus miki Kieff., A. pinicola Kieff. MS., Monardia stirpium Kieff., Bryomyia bergrothi Kieff., Miastor cerasi Kieff. MS., Brachyneura squamigera Winn., Winnertzia fusca Kieff. MS., W. pinicola Kieff. MS., Colomyia clavata Kieff., Colpodia anomala Kieff., Dicerura scirpicola Kieff., Porricondyla venustus Winn., Camptomyia ? binotata Kieff., C. nigricornis Kieff., Holoneurus pilosus Kieff. M.S., Lasioptera rubi Heeg., Baldratia salicorniae Kieff., Stefaniella atriplicis Kieff., Trotteria sarothamni Kieff., Rhizomyia silvicola Kieff., Cystiphora taraxaci Kieff., Macrolabis stellariae Kieff., Arnoldia castanea Kieff. MS., A. sambuci Kieff., A. cerris Koll., Lasiopteryx (Ledomyia) divisa Kieff., L. (Ledomyia) lugens Kieff., Dasyneura sisymbrii Schrnk., D. urticae Perris, Rhabdophaga karschii Kieff., R. pierrei Kieff., Mikiola fagi Hart., Psectrosema tamaricis Stef., Schizomyia galiorum Kieff., Zeuxidiplosis giardiana Kieff., Stenodiplosis geniculati Reut., Thecodiplosis brachyntera Schw., Bremia longipes Kieff., B. ramosa Kieff., Aphidoletes urticariae Kieff., Massalongia rubra Kieff., Hormomyia cornifex Kieff., Monarthropalpus buxi Lab., Pseudhormomyia granifex Kieff., Xylodiplosis aestivalis Kieff., X. nigritarsis Zett., Putoniella marsupialis F. Lw., Endaphis perfidus Kieff., Macrodiplosis volvens Kieff., Clinodiplosis galliperda F. Lw. All from Prof. J. J. Kieffer, Bitsch, Germany, and especially valuable because a number are cotypes

Lepidoptera

Sphecodina abbotii Sm. & Abb., Abbott's sphinx, larva on woodbine, July 13, Mrs Carriere, Albany

Saturnia pavonia Linn., Emperor moth, cocoon on French nursery stock, January 31, Rochester. Through State Department of Agriculture

Anisota senatoria Sm. & Abb., larvae on oak, September 9, L. C. Griffith, Lynbrook. Through State Department of Agriculture

Basilona imperialis Dru., Imperial moth, larva on pine, August 18, Andrew Lackey, Johnsburg

Ctenucha virginica Charp., larvae on pine and gooseberry, L. H. Adams, Johnstown. Through State Department of Agriculture

Halisidota caryae Harr., hickory tussock moth, larvoe on maple, July 11, L. C. Griffith, Lynbrook. Through State Department of Agriculture

Arsilonche albovenosa Goeze, larva, September 27, William Hotaling, Kinderhook

Xylina antennata Walk., green fruit worm, larvae on maple, June 16, Alex Anderson, Stonyford. Same, larvae on apple, June 28, Geneva. Through State Department of Agriculture

Notolophus antiqua Linn., rusty tussock moth, eggs, March 9, H. W. Gordinier, Troy. Same, caterpillars on elm, June 18, H. E. Vaughan, Ogdensburg

Datana ? integerrima G. & R., larvae, July 11, L. C. Griffith, Lynbrook. Through State Department of Agriculture

Schizura concinna Sm. & Abb., red-humped apple caterpillar, larvae on apple, September 10, C. C. Perry, Eagle Bridge

Synchlora viridipallens Hulst, adult, August 4, Louis Capron, Menands

Cingilia catenaria Dru., chain-spotted geometer, larvae on sweet fern, bayberry, August 2, L. C. Griffith, Sag Harbor. Through State Department of Agriculture

Ennomos subsignarius Hübn., snow-white linden moth, eggs on maple, March 28, Edward Thomson, Frost Valley, Denning. Same, adult, July 22, J. C. Ayer, Glen Cove

Phobetron pithecium Sm. & Abb., hag moth caterpillar, larva, September 13, W. A. Bullis, West Sand Lake

Zeuzera pyrina Linn., leopard moth, pupae, July 1, H. I. Newell, Richmond Hill. Same, exuviae on maple, July 5, T. J. Beam, Port Chester. Through State Department of Agriculture. Same, larva on apple, September 17, E. G. Serins, South River, N. J. Through Country Gentleman

Hyponomeuta malinella Zell., ermine moth, larvae on imported French apple stock, June 24, J. H. Dodge, Rochester. Same, larvae on apple, June 27, J. J. Barden, Orleans

Ancylis nubeculana Clem., larvae on apple, September 1, R. H. Ham, Niverville

Dichomeris marginellus Fabr., Juniper webworm, larvae on Juniper, February 28, S. G. Harris, Tarrytown. Same, larvae on Irish Juniper, April 26, L. D. Rhind, Plandome. Through State Department of Agriculture

Aspidisca splendoriferella Clem., resplendent shield bearer, winter cases, March 24, Benjamin Hammond, Fishkill

Hemiptera

Belostoma americanum Leidy, giant waterbug or electric light bug, adult attached to a fish, May 4, J. D. Collins, Utica

Brochymena quadripustulata Fabr., adult, July 15, D. H. Cook, Altamont. Same, nymphs, August 26, W. P. Thorne, Lagrangeville

Blissus leucopterus Say, chinch bug, nymphs on corn, August 5, Fred Wheeler, Mongaup Valley. Through State Department of Agriculture

Haematopinus piliferus Burm., sucking dog louse, adult on dog, January 8, V. P. D. Lee, Altamont

Ormenis pruinosa Say, lightning leaf hopper on matrimony vine, August 26, Mrs C. F. Webber, Athens

Aleyrodes vaporariorum Westw., white fly on coleus, August 26, Mrs C. F. Webber, Athens

Chermes abietis Linn., spruce gall aphis, galls on spruce, June 23, F. F. Briggs, Pocantico Hills. Same, adults on spruce, June 26, S. G. Harris, Tarrytown. Same, galls on spruce, October 12, Theodore Foulk, Flushing

C. cooleyi Gill., galls on Colorado blue spruce, August 4, White Plains, State Department of Agriculture

C. pinicorticis Fitch, pine bark aphid, adults on pine, May 12, M. T. Richardson, New York city. Same, eggs, February 12, Miss Pauline Goldenmark, New York city

C. piceae Ratz., adults and eggs on Nordmann's fir, May 17, Rochester. Through State Department of Agriculture

C. pinifoliae Fitch, pine leaf aphid, adult on black spruce, January 29, Miss Edith M. Patch, Orono, Me.

C. consolidatus Patch, adults on larch, January 29, Miss Edith M. Patch, Orono, Me.

C. floccus Patch, adult on black spruce, January 29, Miss Edith M. Patch, Orono, Me.

C. lariciatus Patch, adults on white spruce, January 29, Miss Edith M. Patch, Orono, Me.

Pemphigus imbricator Fitch, beech blight, nymph on beech, August 31, G. C. Wood, Barneveld

P. tessellata Fitch, woolly maple leaf aphid, adults on maple, June 16, A. P. Knapp, Hillsdale, N. J. Through Country Gentleman. Same, eggs, June 20, Miss May Seymour, Lake Placid

Schizoneura americana Riley, woolly elm leaf aphid, adults on elm, June 5, R. M. Boren, Ballston Lake. Same, adults and young on elm, June 10, W. P. Judson, Broadalbin. Same, adults on elm, June 18, H. E. Vaughan, Ogdensburg

S. lanigera Hausm., woolly apple aphis, nymph on apple, November 9, C. S. Ashley, Old Chatham. Same, Mrs S. H. Niles, Coeymans. Same, November 10, J. F. Rose, South Byron. Same, November 13, Bell & Smith, Castleton. Same, C. C. Woolworth, Castleton

Lachnus abietis Fitch, on balsam, September 8, C. H. Peck, Lake Placid

Psylla pyricola Forst., pear psylla, adults on pear, September 20, John Dunbar, Rochester

Pachypsylla celtidis-gemma Riley, hackberry nodule gall, galls on hackberry, February 16, H. B. Smith, Nashville, Tenn. Through Garden Magazine, Doubleday, Page & Co.

Eulecanium tulipiferae Cook, tulip tree scale on tulip, August 31, O. W. Peterson, Fairfield county, Conn. Through Country Gentleman

Asterolecanium pustulans Ckll., golden oak scale, adults on oak, May 16. Through State Department of Agriculture

A. variolosum Ratz., on oak, September 7, Theodore Foulk, Flushing. Through State Department of Agriculture

Phenacoccus acericola King, false cottony maple scale, young, January 21, Archibald Beresford, Mt Vernon. Same, eggs on maple, July 18, Mrs Alice G. Fisher, Batavia. Same, females and young on maple, October 4, Miss Fanny G. Dudley, Newburgh

Pseudococcus longispinus Targ., mealy bug, February 24, C. E. Olsen, Winfield. Same, larvae on coleus, August 30, Albany. Through Country Gentleman

Pulvinaria vitis Linn., cottony maple scale, females and young on maple, July 26, G. W. Morley, Haverstraw. Through State Department of Agriculture

P. occidentalis subalpina Ckll., immature, August 31, T. D. A. Cockerell, Boulder, Col.

Gossyparia spuria Mod., elm bark louse on elm, July 9, R. H. C. Bard, Syracuse. Through State Department of Agriculture

Eriococcus azaliae Comst., on azalea, November, Brooklyn. Through State Department of Agriculture

Aulacaspis pentagona Targ., West Indian peach scale, adult on imported Japanese flowering cherry, January, P. L. Huested, Kingston. Same, adult on Japanese cherries, February 3. Through State Department of Agriculture

A. rosae Bouché, rose scale on rose, November 13, C. C. Woolworth, Castleton. Same, adults on rose, April 29, L. L. Woodford, Pompey

Chionaspis americana John., elm scurfy scale, crawling young, May 10, W. B. Landreth, Schenectady

C. euonymi Comst., euonymus scale, eggs on ? Euonymus, May 19, C. H. Hechler, Roslyn

Fiorinia fioriniae var. japonica Kuw., adults on Japanese hemlock, June 9, Long Island. Through State Department of Agriculture

Orthoptera

Chortophaga viridifasciata DeG., green-striped grasshopper, nymphs, March 26, N. Ashley, Old Chatham

EXCHANGE

Galls received from Prof. Mario Bezzi, Torino, Italy

Cystiphora sonchi F. Lw. on Sonchus arvensis L., Sondrio, Italy

Dryomyia circinans Gir. on Quercus cerris L., Mantua, Italy

Dryomyia lichtensteinii F. Lw. on Quercus ilex, Macerata, Italy

Dasyneura sisymbrii Shrnk. on Nasturtium silvestris L., Milan, Italy

[1] Perrisia sp. on Cucubalus bacerifer (?) L., Bergamo, Italy

Perrisia sp. on Polygonum bistorta L., Sondrio, Italy

Perrisia alpina F. Lw. on Silene acaulis L., Sondrio, Italy

Perrisia capitigena Br. on Euphorbia cyparissias L., Macerata, Italy

Perrisia crataegi Winn. on Crataegus oxyacantha L., Milan, Italy

Perrisia ericina F. Lw. on Erica carnea L., Como, Italy

Perrisia fraxini Kieff. on Fraxinus excelsior L., Sondrio, Italy

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[1] A synonym of Dasyneura.

Perrisia oenophila Haimh. on Vitis vinifera L., Sondrio, Italy
Perrisia pustulans Rubs. on Spiraea ulmaria L., Sondrio, Italy
Perrisia rosarum Hdy. on Rosa canina L., Sondrio, Italy
Perrisia salicariae Kieff. on Lythrum salicaria L., Milan, Italy
Perrisia ulmariae Br. on Spiraea ulmaria L., Sondrio, Italy
Rhabdophaga rosaria H. Lw. on Salix purpurea L., Sondrio, Italy
Mikiola fagi Hart. on Fagus silvatica L., Bergamo, Italy
Rhopalomyia artemisiae Bouché on Artemisia campestris L., Sondrio, Italy
Oligotrophus sp. on Juniperus communis L., Mallare, Italy
Oligotrophus capreae Winn. on Salix caprea L., Sondrio, Italy
Oligotrophus corni Gir. on Cornus sanguinea L., Relegon, Como, Italy
Oligotrophus reaumurianus F. Lw. on Tilia parviflora Clerk., Sondrio, Italy
Oligotrophus solmsii Kieff. on Viburnum lantana L., Sondrio, Italy
Oligotrophus taxi Inchb. on Taxus baccata L., Mallare, Italy
Mayetiola poae Bosc. on Poa nemoralis L., Sondrio, Italy
Asphondylia sp. on Scrophularia canina L., Selvius, Bergamo, Italy
Asphondylia sarothamni H. Lw. on Sarothamnus scoparius Link., Sondrio, Italy
Schizomyia pimpinellae F. Lw. on Pimpinella magnus L., Como, Italy
Harmandia petioli Kieff. on Populus tremula L., Sondrio, Italy
Harmandia tremulae Winn. on Populus tremula L., Sondrio, Italy
Clinodiplosis vaccinii Kieff. on Vaccinium uliginosum L., ? Valmaleneo, Sondrio, Italy

APPENDIX

MIASTOR AMERICANA FELT

An account of pedogenesis

The remarkable larvae of Miastor, presumably M. americana Felt, were found Oct. 5, 1910 under the partially decayed inner bark and in the sapwood of a chestnut rail used to fence a shady roadside in the vicinity of Highland. Additional material was secured October 19th, and from these two lots we have been fortunate in being able to follow through the larval life cycle and to actually witness pedogenesis, now regarded as a modification of parthenogenesis. These minute larvae are very easily handled and studied and should therefore be extremely serviceable to teachers of zoology and biology desiring to give their classes first-hand information respecting this phase of reproduction. Our studies of this form are given below in some detail in the hope that many teachers will find it advantageous to make use of these larvae in their class work.

Habitat. The moist inner bark of various trees showing incipient decay is the most likely place to find Miastor larvae. Those discussed in these pages were discovered in the fall, working in the partially decayed chestnut bark of a rail fence along a shaded roadside. The larvae were most abundant in the soft, partly decayed bast just beyond the point invaded by various borers in dead wood and the accompanying predaceous Dipterous larvae. An allied, though undetermined, species was taken under similar bark of a chestnut stump in a wood lot. European observers report the occurrence of these and allied larvae under the bark of a variety of trees, such as beech, birch, poplar, oak, elm, ash and ironwood, and even in sugar beet residue.

Recognition characters. It is very probable that these larvae have been repeatedly overlooked by collectors, simply because when occurring singly or in small colonies they present no very striking characteristics. Large colonies of this remarkable form are easily recognized by the masses of more or less adherent yellowish or whitish larvae, and especially by the presence here and there of larger, motionless individuals, some of which usually contain young so well developed as to be easily seen with a hand magnifier. A careful examination with a pocket lens will show, even in the case of isolated larvae, a distinct head and a fuscous ocular spot in the sedgment just behind. The head is flattened, triangular, with a pair

of diverging antennae and quite different from the strongly convex, usually fuscous head of Sciara larvae sometimes occurring in similar situations. Predaceous larvae likely to be associated with Miastor, may be instantly recognized by the body tapering to the small anterior segments, and especially by the chitinized, usually fuscous, hooked mouth-parts. Small Dipterous maggots having a length of one-twentieth to one-eighth of an inch and occurring under conditions described above, should be carefully examined if one is searching for this or allied species.

Value to zoologists and biologists. Miastor larvae and their allies should be of great service to teachers of zoology and biology, since they admit of the study at first-hand of one form of parthenogenesis. It is possible with a no more elaborate outfit than an ordinary student's microscope equipped with a three-quarter objective, a microscopic slide and a few cover glasses, to observe the vital activities of the young larva, to see the muscular, respiratory, digestive and nervous systems, to identify the ovaries and to watch the gradual development of the semitransparent embryos within the mother larva. Furthermore, this larva is well adapted to more exact histological methods, being soft and therefore an excellent subject for serial sections and stains, particularly as it is comparatively easy to secure from one colony a series of individuals representing different stages of development.

There are other considerations aside from the interest attaching to their morphology and biology which should appeal strongly to the teacher of zoology. These larvae are widely distributed and, with an understanding of their habits, there should be little difficulty in finding them. Moreover, they are small, and a piece of wood six inches long, three inches wide and half an inch thick may contain or produce material enough for a fair sized section or class in zoology. The larvae are prolific and under favorable conditions would probably multiply at any season of the year. This is certainly true of the fall, the early winter and the spring. They are so amenable to artificial conditions as to make it possible to keep them alive for at least a month in microscopic cells, and with care a larval generation will develop in such restricted quarters. We have kept larvae healthy and multiplying for more than three months with nothing more elaborate than a moist piece of decaying wood clamped lightly to an ordinary microscopic slide. These remarkable larvae are very hardy. Prolonged dryness simply results in a suspension of activities, while they are quite resistant to an

abundance of moisture. We have kept them alive in sealed water-filled cells without food for five weeks. With our present knowledge we see no reason why artificial colonies might not be established in the vicinity of a zoological laboratory and maintained with very little or no attention from year to year, if not for a decade or more.

Description. The parents of these remarkable larvae are small midges belonging to the Dipterous family Itonidae, better known as the Cecidomyiidae or gall midges. The members of this family are all small Diptera with the tibiae unarmed apically, the coxae not produced and the wings usually with but three or four long veins and no cross veins. Extreme forms may have six or seven long veins and one cross vein or, as a result of reduction, the veins may have nearly disappeared.

The subfamily Heteropezinae, to which Miastor and its allies belong, comprises a number of exceedingly peculiar forms, some of them most remarkable on account of the great degree of specialization by reduction — physiological as well as morphological. Members of this subfamily may be separated from the Itonidinae by the absence of circumfili, and from the Lestremiinae by the great reduction in the venation, there being at most, three long veins. The metatarsus may be longer than the following segment, while the number of tarsal segments may be reduced to two. Certain species have quinquearticulate tarsi and the wing membrane thickly clothed with rather broad, striate scales. The production of larvae by larvae or pedogenesis is known to be true of several genera referable to this subfamily, the larvae of which appear to live for the most part in decaying vegetable matter and are therefore likely to be found in searching for Miastor larvae. The adults of Miastor appear in June, while the one known American species of Oligarces was taken in July. The following table will facilitate the recognition of the genera in this group.

KEY TO GENERA

a Metatarsus longer than the second segment
  b Tarsi quadriarticulate; 3 long veins; palpi biarticulate — Miastor Mein.
  bb Tarsi triarticulate; 2 long veins; antennal segments cylindric — Heteropeza Winn.

aa Metatarsus shorter than the second segment
  b Tarsi quinquearticulate
    c Wing membrane finely haired
      d 3d vein extending to the apex of the wing
        e Palpi quadriarticulate
          f 5th vein forked — Haplusia Karsch
          ff 5th vein simple — Johnsonomyia Felt

ee Palpi triarticulate — Meinertomyia Felt

dd 3d vein not extending to the apex of the wing

eee Palpi uniarticulate — Leptosyna Kieff.

e Palpi biarticulate — Frirenia Kieff.

ee Palpi triarticulate — Epimyia Felt

cc Wing membrane scaled; 3 simple veins; palpi triarticulate — Brachyneura Rond.

bb Tarsi biarticulate — Oligarces Mein.

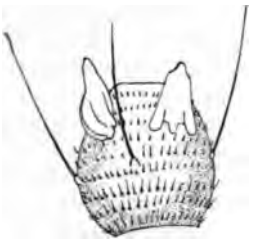

Fig. 7 Fifth antennal segment of Miastor americana, greatly enlarged. (Original)

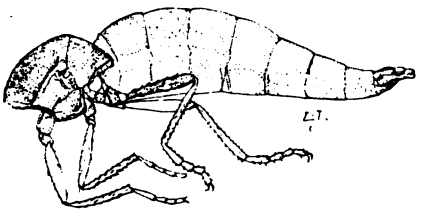

Fig. 10 Side view of thorax, legs and abdomen of Miastor americana. (Original)

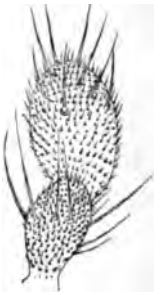

Fig. 8 Palpus of Miastor americana, greatly enlarged. (Original)

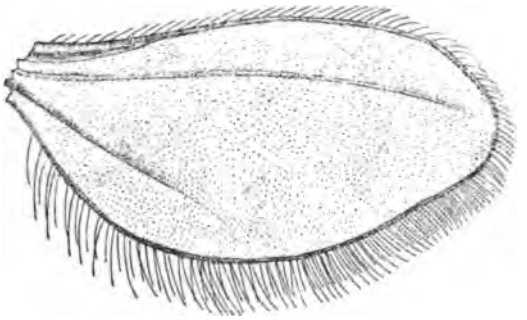

Fig. 9 Wing of Miastor americana, greatly enlarged. (Original)

M. americana. *Female.* Length 2.5 mm., slender. Antennae extending to the base of the coxae, sparsely haired, brown; 11 segments, the first short, stout, irregularly subglobose, the second ½ longer, the fifth subcylindric, with a length about ¼ greater than its diameter, tapering at both extremities, subsessile; a very sparse subbasal whorl of stout setae; subapically and apparently on the ventral surface, a pair of large, irregularly subconic, semitransparent processes (fig. 7); the distal segment subglobose, broadly rounded apically. Palpi biarticulate, the first segment irregularly oval, the second ½ longer, broadly oval, both sparsely setose. Mesonotum

dark brown. Scutellum reddish brown, postscutellum fuscous yellowish. Abdomen pale salmon, fuscous basally, yellowish apically. Wings hyaline, costa pale yellowish, subcosta uniting with the margin at the basal third, the third vein, curving distally, just before the apex, the fifth simple and disappearing just before the basal half; fringe long, slender. Legs a nearly uniform yellowish brown, the tarsi quadriarticulate, the first segment short, about ½ longer than the second, which latter is distinctly longer than the third, the fourth a little longer and stouter than the second; claws long, slender, simple, the pulvilli nearly as long as the claws. Ovipositor short, the lobes long, slender, triarticulate, the basal segment stout, subtriangular, the second longer, subrectangular, the third narrowly oval, all sparsely setose; on the venter of the seventh abdominal segment there is a submedian pair of obpyriform, chitinous appendages, possibly orifices of odoriferous glands.

Larva (presumably M. americana). Length 1.25 to 4 mm. Young larvae yellowish or whitish transparent, the larger larvae whitish or reddish orange. The large, white larva is rather stout, tapering somewhat at both extremities and frequently nearly filled with white adipose tissue. There are 13 body segments. The head (pl. 20, fig. 21) is small, triangular and frequently retracted within the body segments. The palpi are short, stout, biarticulate and arising from the anterior portion of the head, the tip of the head usually fuscous. The irregularly bilobed ocular spot is usually seen as a fuscous mass in the third segment. The posterior extremity tapers to an obtuse apex bearing a series of 6 stout, frequently recurved, cuticular processes. The body segments are banded ventrally (pl. 20, fig. 21) with closely set series of short, stout spines pointing backward, these spines being most strongly developed upon the anterior body segments, especially the third, fourth and fifth (pl. 22).

The quiescent larva, easily recognized by its somewhat stiff attitude, due probably to the relaxation of the transverse muscles girdling each segment, may be whitish and contain semitransparent embryos, easily seen by reflected light (pl. 23, fig. 1) or yellowish and filled with nearly mature embryos (pl. 21, fig. 1).

The young larvae are 1.25 to 2 mm. long and present all the characters described above for the larger white larvae except that they are yellowish or yellowish transparent, usually more slender and appear to have a relatively much better developed musculature.

[illegible] The muscles are generally well developed in the young larvae. They consist of a series of longitudinal and oblique muscles extending from the anterior to the posterior margins of the body segments. There are a number of transverse, girdling muscular bands which are particularly well developed at the union of the body segments though several somewhat broad bands may be observed near the middle of each segment.

Respiratory system. The tracheal trunks comprise a double series on each side extending nearly the entire length of the body and sending minute branches to lateral spiracles on the fourth to the eleventh body segments. The dorsal trunks are united to each other by transverse tracheae in the posterior third of body segments five to eleven inclusive and, in addition, send minute branches to the various organs of the body. The tracheal system of a living, semitransparent larva may be easily examined in a water mount.

Nervous system. This is composed of the pyriform submedian optic lobes and the fuscous, lobulate, socalled ocular spot, the bilobed brain in the fourth and fifth body segments and a series of ganglia united by submedian nerves as follows: A broadly oval ganglion occupying the length of the third body segment and with a width fully equal to half its diameter; a shorter, more slender ganglion in the anterior portion of the fourth segment; a broadly pyriform ganglion in the anterior third of the fifth body segment. Separated slightly therefrom, another ganglion lies in the posterior portion of the fifth and the anterior part of the sixth body segments. It is a little narrower than the preceding though it has an equal length. The fifth and sixth ganglia, each short, subquadrate, occur in the sixth body segment; the seventh ganglion is one-half longer than the sixth and is situated in the middle of the seventh body segment; the eighth to the twelfth body segments each appear to have one ganglion, the posterior one almost extending to the anterior margin of the thirteenth body segment.

Digestive system. The digestive system, difficult to study because of its being largely inclosed by nearly opaque adipose tissue, consists, according to Kahle, of a comparatively simple tube extending the entire length of the body, the granular salivary glands occurring in the fifth to the ninth body segments, while the long, slender, malpighian tubes may be found in the 11th to 13th segments, inclusive.

History of pedogenesis. The discovery of this remarkable phenomenon is credited to Nicolas Wagner, professor of zoology at Kasan. He published a short note in the *Journal of the University of Kasan* in 1861 or 1862, and in 1865 a detailed account. The latter was held by the editor for almost two years because of its "almost incredible" character. The observations of Wagner were confirmed by Meinert and Pagenstecher in 1864, and by Hanin, Leuckart and Mecznikoff in 1865. Wagner believed at first that the embryos originated in the adipose tissue, at the expense of which they develop very largely. Later he, Leuckart and Mecznikoff satisfied themselves that the embryos originated from ovaries.

The investigations of these scientists covered approximately a decade, 1862 to 1872, which was followed by a long period of apparent lack of interest in these larvae, very little original being published from the latter date until the exhaustive studies in 1908 by Kahle, who employed modern laboratory methods, demonstrated the general correctness of the earlier observations and satisfied himself that the process was a true parthenogenesis. It does not seem to have occurred to any one that these larvae might be of great service to the teacher of biology.

This method of reproduction has been observed by Meinert in Miastor, Oligarces and Meinertomyia (Pero Mein.) and by Kieffer in Leptosyna. The latter believes the same to be true of Frirenia, though he has not observed mother larvae, since the females contain the unusually large eggs characteristic of genera reproducing in this manner.

Pedogenesis or close approach thereto is known to occur in the Chironomidae. Grimm in 1870 describes a larval Chironomus in which eggs develop, they escaping, however, from paired submedian ventral orifices in the eighth abdominal segment of the pupa. This must be construed as at least a modification of the process exhibited by Miastor and its allies. Professor Johannsen recorded in 1910 a pedogenetic larva, Tanytarsus dissimilis Jhns., which had come under his observation and that of the late Dr James Fletcher, though no data has been published to show the exact character of this process. Professor Johannsen also refers to an account of pedogenesis in this genus observed in Bohemia by Professor Zavrel.

Habits. These larvae appear to thrive only in the moist, partly rotten inner bark and punky sapwood which has not been invaded to any considerable extent by other Dipterous larvae or Coleopterous borers. They exhibit a manifest tendency to occur in segregated masses, frequently between loose flakes of bark or in rather broad crevices. These colonies contain in autumn old empty skins of mother larvae; a number of yellowish mother larvae with approximately five to fifteen young within; very numerous, small, yellowish larvae showing no trace of embryos; a number of white, various sized active larvae, frequently white, sometimes semitransparent; and a few quiescent white larvae containing young embryos. Such larval colonies are most likely to be found in somewhat flaky inner bark, especially where conditions allow several larvae to lie side by side (pl. 26, fig. 1).

Slender, yellowish larvae are often found lying between wood fibers, in some instances apparently having penetrated several inches from the nearest adjacent larvae. These latter do not appear to grow so rapidly as is the case in the more populous colonies, and they also seem to be less prolific, since the few larvae we have observed under such conditions, produced only three or four, and mostly but one, young. The small, yellowish larvae lying in crevices, mentioned above, frequently occur in series, sometimes one or two lying side by side. They move comparatively little, action being confined largely to the head and the semitransparent anterior body segments. Such larvae appear to remain almost unchanged for two weeks or more. These muscular larvae, with their bands of retrose spines especially well developed on the anterior body segments, are admirably adapted for forcing their way between partially rotten tissues, a procedure which is also of material service in giving them relative immunity from attack by natural enemies. The small yellow larvae were most abundant in our material during the winter months.

Active larvae crawl rapidly over moist wood and glass, and have even been observed wriggling between colonies of mold. Lack of moisture appears to cause a partial suspension of vital activities, while flooding does not seem to be very injurious. The mouthparts of the larvae, though the anterior portion of the head is strongly chitinized, appear to be comparatively weak, and, while we have repeatedly observed these larvae moving the head about and examining adjacent tissues, we have seen no indication of gnawing or boring. The alimentary canal contains little that can be discerned with the aid of a compound misroscope, and we are inclined to believe that a considerable portion of their nourishment is absorbed by osmosis after escaping from the mother larva, as well as before. It would appear as though the several types of larvae occurring in a colony are possibly only modifications, due to the relative amount of nourishment obtained by the individual.

Normally, reproduction by pedogenesis occurs throughout the warm months of the year and even into late fall, and commences in early spring, the cold weather of winter simply causing a suspension of activities. Dr Kahle, after an extended series of observations, was led to believe that asexual multiplication might continue uninterruptedly for possibly a period of two or three years. This appears reasonable, since somewhat recent experiments by Slingerland have shown that a plant louse might produce nearly 100 asexual

generations in almost four years and presumably was capable of continuing this much longer. The adults of Miastor and Oligarces occur in midsummer, a season when the midges of most of these forms are probably abroad.

Biological observations. The first larvae secured were taken October 5, 1910, placed in an ordinary fruit jar with moist sand and subsequently allowed to become rather dry. A second lot was obtained October 19 and on examining the latter November 18th, an adherent mass of young larvae evidently recently escaped from the mother larva was found. Soft, partially rotten wood was taken from the earlier lot presumed to contain little or nothing alive, and one or two of these young larvae placed in a groove in each piece of wood, the latter being attached by light clamps, either directly to a microscopic slide or held between a pair. These preparations were kept in a closed tin box on damp blotting paper. It was hoped that we would be able to watch the development of the one or more larvae thus placed in each piece of wood. Most of these for some reason or other escaped and we soon found that the additional moisture given these pieces resulted in renewed activities on the part of many larvae concealed in the woody tissues. On November 28, ten days after these preparations had been made, numerous young larvae were observed in most of the preparations, the majority probably recent young of larvae stirred to renewed activity by the addition of moisture. Throughout November and in early December large, white mother larvae capable of producing from five to perhaps fifteen embryos were frequently seen. The latter part of December and during January large, white larvae were difficult to find and the major portion of the reproduction was by the small, yellow mother larvae usually occurring in crevices in the sapwood and producing only one or two young. These preparations afford an excellent opportunity for determining the duration of the quiescent period under nearly natural conditions. This was found, as a result of observations upon a number of larvae, to be in the vicinity of a week, the movements of the embryo with the fuscous ocular spot and brown anterior portion of the head being observable about five days prior to the escape of the young. The occurrence of a small amount of mold did not seem to have a material effect upon the health of the larvae, and the same was true respecting the presence of mites, Tyroglyphus, which were upon occasions rather abundant in some of the preparations. The larvae crawl readily between the glass and the wood, occasionally

making their way to the margin of the preparation and sometimes escaping. A few were found lying upon the damp blotters in the bottom of the box, others between the blotters and more under the lower blotter on the tin bottom of the box. The larvae are evidently able to remain active for considerable periods without nourishment and with comparatively little oxygen, since it was observed that flooding of the preparation, even though continued for two or three days, apparently had no ill effect upon the larvae — subsequently we found that larvae would live submerged several weeks and the embryos develop.

The above was continued by isolating one or more larvae on ordinary microscopic slides. Each of these contained several small slivers of wood approximately .2 mm. thick and 1 to 1.5 em. long. These were laid upon the slide, moistened, several larvae added and a square cover glass placed over the whole, the margins being more or less perfectly sealed with vaseline. These preparations were designed primarily to secure more accurate data as to the length of the quiescent period, to facilitate observation upon the development of the embryo and also to ascertain the feasibility of rearing the larvae under such conditions. It was soon noted that while the vital processes were not at once inhibited by submersion, they were greatly retarded and if flooding was long continued, the embryos were unable to escape from the mother larva, though apparently well developed.

One moderate sized, apparently quiescent larva with finely granular contents and a brownish discoloration on one side was placed in such a cell December 12, 1910, together with a moderate sized, yellowish or yellowish white larva and a number of smaller ones. The 16th it was evident that the adipose tissue of this large larva was disintegrating, the several embryos being about one-half the length of the mother larva. On the 22d the embryo was apparently about three-fourths the length of the mother larva and there were no signs of either head or ocular spot. The next day the developing ocular spot was seen as a pair of narrowly oval, fuscous, submedian bodies, while most of the posterior part of the larva was filled with large, cuboidal cells arranged in a series of columns. The embryo at this time extended from the fifth to the thirteenth body segments of the mother larva. The following day the ocular spot was more evident and the apex of the head discernible. The 27th we were able to recognize two embryos, both with the large cells as described above. The 30th there was a distinct bulging

of the mother larva in the region of the fifth body segment, a condition presaging the nearly developed embryo. The next day the ocular spot was black. Observations were continued daily from January 1st to the 13th, during which time development appeared to be slow and a clear definition of the changes undergone almost impossible because of the condition of the cell. January 16th the embryos had escaped.

The moderate sized, yellowish or whitish larva mentioned above was lost sight of for a time, not being located till December 23, 1910, at which time it was found well established on the underside of a splinter of wood and with a length of about 3 mm. It remained moderately active for a time, two embryos being observed the 26th, at which time its color approximated closely that of the wood and accounted in large measure for its being overlooked earlier. The 28th the adipose tissue of the mother larva had nearly disappeared and on the 31st an ocular spot was visible in the young. January 1st the head and ocular spot of two embryos were recognized, and on the 5th embryonic movements were observed. The next day one embryo had extruded its head through the skin of the mother larva. Our records show that embryos remained within this mother larva till the 20th, possibly one or more perishing.

There were at least three small, yellowish larvae placed in this preparation with the two larger ones discussed above. These remained active for some days, two being located as quiescent, each containing an embryo about half the length of the mother larva, December 23, 1910, and from this on were subjected to daily observation. The first of these showed a grouping of the cells in rows the 24th, which became more distinct the next day, and on the 26th a median tract of darker cells was observable. The 28th the embryo extended from the second to the eleventh body segments of the mother larva and showed rather distinct masses of adipose and mesodermal tissue (pl. 35, fig. 3). The ocular spot was evident and the head slightly fuscous. On the 30th movements of the anterior extremity of the embryo and streaming of the body contents were observed, the mesodermal tissue was less conspicuous and the adipose tissue occupied more space. The embryo escaped from the mother larva January 1st. This was unusually early and may have been hastened by artificial causes.

The second small, yellowish, quiescent larva was located December 23, 1910, at which time it contained a large-celled embryo with a length [illegible] that of the mother larva. Three days

later the embryo extended from the fifth to the thirteenth segments of the mother lavra, the cells being arranged in indistinct rows and larger at the extremities. Owing to its position, it was impossible to properly illuminate this mother larva. The ocular spot and fuscous head were observed on the 30th and an active, well-developed larva seen January 2d, which remained within the skin of the mother larva till the 12th, an unusually long period, due possibly to the mother larva being partially surrounded by vaseline and therefore deprived of a proper supply of oxygen.

Three months after the establishment of the cell containing the larvae discussed above, their progeny were living under substantially the same conditions and gave every indication of producing young in due time.

A large, white, active larva was isolated under another slide December 12, 1910 with the conditions practically as outlined above. Six days later this larva had worked itself to the margin and become practically inclosed in a vaseline, water-filled cell where it remained for over a month, namely till January 20th. The development was unusually slow, probably due in large measure to the deficient supply of oxygen. Young, oval embryos were observed in the region of the sixth and seventh body segments December 19. On the 24th several embryos were found on the venter in the region of the tenth or eleventh segments, each with a length nearly equal that of the body diameter. There was a gradual increase in length and on the 26th one extended from the eleventh to the fourteenth segments of the mother larva. The adipose tissue was yellowish and reticulate by the 29th, though no signs of ocular spot or mouth parts were to be seen. January 2d a slight row of cells was visible in one embryo, this median streak becoming more apparent on the 5th. Extended masses of large, cuboidal cells were observed on the 7th, the ocular spot showing as a pair of minute, brownish spots. On the 16th well formed, embryonic heads and brown ocular spots were visible. This appeared to be about as far as development could go without additional oxygen, and though the vaseline cell was ruptured on the 20th no larvae escaped. The record is interesting since it gives an idea of the vitality of these larvae under adverse conditions.

Another quiescent, white larva containing at least two embryos was isolated December 12, 1910. The adipose tissue was granular and irregular. On the 16th the larva was nearly filled with whitish transparent embryos, the latter with a distinct median

streak. Five days later one embryo had a length equal to one-half that of the mother larva, the embryonic adipose and mesodermal tissue were rather distinct, while the adipose tissue of the mother larva was largely absorbed. On the 22d the form of the mother larva was distinctly modified by the obliquely-lying young, each with a length approximately three-fourths that of the parent. The next day we observed the mesoderm, composed of irregularly arranged, subhexagonal cells, accompanied by the appearance of incipient ocular spots in various embryos. The tip of the head became fuscous by the 28th and on January 5th, slight movements of the embryos were observed. Owing to the reduced oxygen supply, due to the larva being in a practically sealed cell, the embryos experienced difficulty in escaping. One was observed January 9th with the seven anterior segments protruding from the posterior extremity of the mother larva, remaining in the same position and nearly motionless the three following days. The cell was opened January 14th and the mother larva given air, but the action was apparently too late, as the young failed to revive. There appears to be sufficient oxygen in the tissue of the mother larva to permit the embryos to become fully developed.

Methods. The material taken in October was kept in ordinary fruit jars for a time, some of these at least being allowed to become rather dried. There was very little or no multiplication. On November 18th small pieces or slivers of somewhat dried wood containing these larvae were either clamped directly to ordinary microscopic slides or laid between two held together by means of light wire clips. These portions of infested wood were kept on moistened blotting paper in a dark, tin box, being examined every two or three days. Large, white mother larvae were produced from time to time and occasionally considerable colonies of small young were observed in the vicinity of the empty skins of mother larvae. Such preparations enabled us to keep track, not only of a colony but, by noting the location of quiescent larvae, even of individuals. Later this series was supplemented by a few fragments of wood laid upon microscopic slides, covered with large, square cover glasses and the margins more or less perfectly sealed with vaseline. The cell thus formed was kept moist and sometimes flooded with water. Under such conditions full grown white larvae, quiescent larvae and small, white or yellowish larvae were also studied. They apparently thrived for one week at least. Finally we selected a series of small, yellowish, active and quiescent larvae, placed them in water cells

and observed the embryos and their various stages of development, photomicrographs being successfully made from this living material.

The observations on the small lots of material noted above were checked by examinations of the fruit jars containing larger amounts of material. The latter jars were especially useful because the very numerous maggots made it possible to select at one time practically all stages, which were mounted in considerable abundance. Some of the larvae were cleared with potassium hydrate and then stained with Fuchsin, Hematoxylin, Eosin and Eosin-Hematoxylin. The actions of the stains were all somewhat unsatisfactory and the majority of our most successful mounts were entire larvae in ordinary balsam preparations which had been thoroughly cleared. The study of the mounts was checked by examination of living material as detailed above.

Embryology. The development of the embryo may be observed in the living larva. It is easily seen in the larger, white individuals common in the fall and producing a number of young, though the changes in the embryo are best observed in the small, yellow larvae, especially if they are mounted in shallow water cells.[1]

The region of the ovaries is marked in the large, white larvae by an irregular, yellowish green streak in the tenth or eleventh segments. A close examination of such a larva may disclose the oval, large-celled ovaries nearly concealed by the submedian masses of opaque, white adipose tissue, especially if the larva rolls slightly. These organs are more easily detected in the young yellowish larva. They are submedian, whitish transparent, contrast rather strongly with the darker, more refractive adipose tissue and are located in the posterior portion of the tenth or the anterior part of the eleventh segment, one frequently being somewhat in advance of the other. They are composed of globular or oval, nucleated cells.

The youngest embryos we have observed are oval, granular and may be found in the large, white larvae in the vicinity of the ovaries. The motion of the internal organs appears to distribute the embryos through the body, there being from one to as many as seventeen in individual mother larvae. The young embryos are semitransparent and present a strong contrast to the opaque adipose tissue of the large, white larvae or the denser cells of the small, yellowish larvae. The youngest embryo photographed is

[1] We have used a ring of vaseline to support the cover glass and found such a cell very satisfactory as well as economical.

represented on plate 30, figures 2 and 3. It occurred in a small, yellow larva and had a length nearly equal to that of the ninth segment of the mother larva, its width being about one-fourth the diameter of the parent. This embryo is evidently in the morula stage, it being composed of a rather indistinct mass of irregular, closely placed cells, apparently with a slight infolding, the beginning of the blastoderm. At the posterior extremity there is a group of nucleated, large, polar cells. The next stage observed, though not photographed, was seen in larva Y. This embryo had a length equal to nearly twice the diameter of the mother larva. It was narrowly elliptical, with a length approximately three times its diameter and the polar cells, though visible, were not so evident as in the embryo described above. At its anterior extremity there was a slight thickening, apparently the much reduced cells of the corpus luteum. The median portion was occupied by a rather broad streak of dark, granular cells, bordered on either side and at the extremities by lighter, small-celled tissue. A more advanced stage is shown on plate 30, figure 1, and plate 31. This represents an embryo dissected from the large, white type of mother larva. It shows a distinct darker ectoderm and a lighter mesoderm, the anterior extremity having a conspicuous cap of large, dark cells. Portions of the posterior extremity and of the middle of the same embryo are represented still more enlarged on plate 31, figures 1 and 2. The time required for the small embryos to migrate from the region of the ovaries and develop to such an extent as described above and thus produce a quiescent stage in the large, white type of mother larva is approximately four to five days, much appearing to depend upon the size of the mother larva and the number of embryos present. The latter are perhaps most easily seen when viewed by reflected light (pl. 23 fig. 1, 2). The next stage in the development is illustrated on plate 32, figure 1. The embryo has a distinct cephalic cap of dark-celled tissue, a well defined germinal streak, the latter being broadly produced to one side in the region of the anterior third. The same general condition, though in a more advanced stage and apparently from a somewhat different viewpoint, is illustrated on plate 32, figure 4, and plate 33, figure 2, the dark ectoderm occupying one-third the width of the embryo and extending from approximately the region of the sixth to the twelfth segments; the cephalic cap persists as before. This condition appears to be followed shortly, though we have observed it somewhat clearly only in embryos developing in

the large, white mother larvae, by a great increase in the ectoderm, accompanied by its folding and extension anteriorly around the posterior extremity, the development of the large lobes anteriorly and its segregation into somatic masses, indistinctly shown on plate 27, figure 2, and apparently producing a peculiar cuboidal aspect illustrated on plate 28. The greatly developed mesoderm includes a series of large, cuboidal cells, some at least probably being the polar cells, and a certain portion destined to develop into a much more conspicuous mass to be described later. These changes are accompanied by a shrinking of the embryo from the extremities of the amniotic sac and the development of the digestive system by an invagination from both extremities. This latter is indicated in living embryos of young yellowish larvae, by the formation of irregular lobes at each extremity and the appearance in the region of the sixth to the twelfth segments, of a considerable mass of large-celled tissue, occupying most of that portion of the body cavity and which we believe to be mesoderm (pl. 35, fig. 2) and identical with that mentioned above. The changes from now on are rapid. This conspicuous mass of mesoderm gradually becomes absorbed or reorganized into organs such as the digestive system, its appendages and especially the ovaries, while the developing adipose tissue expands, occupies more space and produces a three-rowed appearance in the embryo (pl. 35, fig. 3). Development of the head now proceeds, the mouth parts become more definite, the ocular spot visible and the lobes at the posterior extremity become well defined. Motion may be observed in the embryo and shortly it is ready to escape from the mother larva. The length of the fully developed embryo is about 1 mm. It is frequently nearly as long as the small, yellow mother larva and approximately half as long as the large, white larva.

The development of the embryo reacts upon the mother larva and she soon assumes a rather characteristic quiescent form, undoubtedly an outcome of her lowered vitality due to the rapid absorption of nourishment by the young. This results in the relaxing of the muscles, especially the transverse girdling bands at the margins of the segments. The change in the condition of the mother is probably explainable solely upon physiological grounds. The time elapsing between the assumption of the quiescent stage by the mother larva and the escape of the young is about seven days. The first part of this period the embryos rarely exhibit signs of life, though distinct motions of the head and anterior segments

may be observed five days before they escape. The embryos are inclosed in the amniotic sac, which latter is ruptured before they escape from the body of the mother larva. There is a marked tendency among the embryos, when more than one occurs, to develop with their heads toward both extremities of the mother larva.

The growth of the embryo is correlated, as alluded to above, by interesting modifications in the mother larva. The large, well developed mother larva is easily recognized by her plump condition and the nearly solid, submedian masses of white adipose tissue filling the body from the fifth or sixth segment to the posterior extremity. Shortly after the escape of the embryos from the ovaries we observe clear patches (pl. 23, fig. 1), here and there in the mother larva, bordered by cells well filled with adipose tissue. Within a few days there is a striking modification and these large cells lose, probably by osmosis, a large proportion of the white, fatty matter and assume a somewhat reticulate character (pl. 23, fig. 2), which is soon followed by their disappearance, and the embryos absorbing practically all of the contents of the mother larva.

Records of individual embryos. The embryo in larva *A* was first detected January 17th. It then had a length about equal to two and one-half body segments of the mother larva. There was a distinct median streak of large, irregular cells, with a broad projection to one side near the anterior third, and a distinct cephalic cap of dark cells at the anterior extremity (pl. 32, fig. 1). The next day the germinal strip occupied an area approximately equal to one-third the width of the embryo (pl. 32, fig. 2), extending the following day to about half the width of the embryo, the clear space just behind the cephalic extremity being decidedly smaller. At this time the embryo had increased in length so that it extended from the posterior third of the fifth to the anterior fourth of the eighth body segment of the mother larva. There was some increase in length and minor changes in development from that date to the 27th, at which time there was a remarkable change, the germinal streak and its production to one side becoming narrower and being composed of unusually large cells; this change was soon followed by disintegration, the condition on the 28th being well illustrated on plate 32, figure 3.

The embryo of larva *B* was recognized January 17th, at which time it extended from the fourth body segment of the mother larva to the twelfth. The greater portion of the embryo consisted of a nearly uniform series of small, globular cells, though a darker area was visible on one side near the middle (pl. 34, fig. 1). Pulsa-

tions were visible in the body of the mother larva. The next day a series of moderately large, cuboidal cells were observed near the posterior extremity. This tissue became more distinct as development progressed, it becoming more evident by the 21st and occupying a still more prominent place the 23d and 24th. On this latter date two-thirds of the posterior portion of the embryonic body were filled with this tissue, somewhat as illustrated on plate 35, figure 2. The masses of adipose tissue on either side commenced to develop and eventually overspread and apparently absorbed in considerable measure the substances of the mesodermal tissue, a portion of which apparently develops into the ovaries. The embryonic digestive tract, apparently marked by large-celled tissue, appeared on the 27th to be nearly continuous throughout the entire length of the embryo. The embryo had shrunk a perceptible distance from the ends of the amniotic sac and the developing extremities were observed. The lobes of the antennae were recognized the following day as obtuse, buttonlike projections having a length less than three-fourths their diameter. Two days later the antennae had a length a little greater than their diameter; the ocular spots were indicated by indistinct, submedian, pigmented areas; the lobes of the brain could be traced; the salivary glands were submedian, narrowly lanceolate masses of large, glistening cells lying in presumably the sixth or seventh segments of the embryo, while the mesodermal tissue had retracted somewhat. The posterior extremity of the embryo was also well defined. February 1st there were three distinct rows of embryonic tissue, the two strips of adipose tissue and the large-celled mesoderm, the latter being less extensive the following day and largely obscured by adipose tissue on February 3d. There was a slow development from this time subsequently. On the 8th the ocular spots were light brown, diffuse, and the semitransparent mouth parts well developed, a fuscous appearance showing on the 9th. This embryo failed to escape from the mother larva.

The embryo in larva *C* extended from the third to the eleventh segments of the mother larva and had a distinct median streak January 17th. The latter on the 20th was seen to be composed of smaller, dark cells. The next day the embryo extended from the third to the middle of the twelfth segment of the mother larva. Development continued until the 27th, at which time it was nearly in the condition illustrated on plate 35, figure 2, the posterior portion being largely occupied by the mesodermal tissue. The an-

terior five or six segments of the embryo were semitransparent and the ocular spots represented by minute, brownish, submedian, pigmented areas. The next day the three-rowed condition, indicating the development of adipose tissue, was more apparent, while the lobed posterior extremity of the embryo was fairly definite. On the 30th developing salivary glands were distinguished near the anterior extremity of the adipose tissue. Free movements of the embryo were noted the 31st, and on February 1st it was seen that the head was well developed though semitransparent, the antennae having a length twice the diameter. The mesodermal tissue was obscured or absorbed to a considerable extent by the developing sublateral masses of adipose tissue. The head of the embryo was slightly infuscated on the 2d and the ocular spots purplish brown. Free movements of the embryo continued and on the 6th the mesoderm was largely concealed by adipose tissue. There was comparatively little development from this date onward, though the embryo continued active in the mother larva till the 10th. Owing probably to an insufficient supply of oxygen it was unable to escape.

One larva (*H*) separated January 17th, contained two embryos, each with a length about half that of the mother larva and both showing a distinct infolding near the middle of the germinal streak. The posterior extremities of these embryos showed several exceptionally large, compound cells — polar cells. Six were observed in the anterior embryo and apparently three in a row in the posterior embryo, the latter apparently moving anteriorly. Unfortunately this promising larva was accidentally destroyed.

Larva *I*, isolated January 17th, contained an embryo extending from the fifth to the eleventh body segments of the mother larva. The next day four presumably polar cells were recognized at the posterior extremity. There were no evident streaks in the embryo. On the 19th one very large aggregation of unusually dark cells was observed just before the posterior extremity, the opposite extremity being largely filled with globular ectodermal cells, especially abundant on one side. The following day a distinct tract of darker tissue was observed on one side of the embryo, extending from its anterior third to its posterior fifth and representing approximately the area occupied by the mesodermal tissue. January 21st the embryo extended from the fifth to the anterior margin of the thirteenth segment of the mother larva. There was a distinct fold of ectodermal tissue, presumably in the region of the

eighth to the twelfth embryonic segments, extending a little over half the width of the embryo. Posteriorly there were several large, globose, nucleated cells, presumably polar cells, while at the opposite end there was a considerable mass of large cells having a diameter of one-fourth to one-third that of the embryo. Two days later the posterior extremity of the embryo contained a mass of large-celled tissue in which were several larger, indistinct, presumably polar cells. The large, glistening mesodermal tissue was observed in the region of the ninth to the twelfth segments, while the sublateral developing adipose tissue was seen on either side. This condition is well shown in a photograph taken the following day (pl. 35, fig. 2), at which time the embryo exhibited distinct movements. The rather well formed head was colorless and moved from side to side. Streaming of the body contents was observed though the fat bodies occupied a comparatively small space on either side. The fine-celled, slender, malpighian tubes were noted. The posterior extremity had well developed lobes. On the 25th the median mass of mesodermal tissue had begun to contract, the developing adipose tissue increasing considerably. Two days later the head was well developed; the ocular spot black; the salivary glands were recognized; the malpighian tubes were distinct, while the mesodermal tissue extended approximately from the tenth to the twelfth segments and had a width only about one-fourth the diameter of the embryo. The following day the embryo escaped from the mother larva.

Larva *N* was a small, yellow larva separated January 30th and containing an embryo extending from the posterior third of the ninth to the posterior third of the eleventh segment of the mother larva. The embryo exhibited a distinct germinal strip extending from the anterior third to the posterior fourth and with a broad band of ectodermal tissue extending to one side and including approximately the middle of the embryo. The anterior extremity of the embryo is capped as it were with dark-celled tissue, while large yolk cells may be seen here and there in the germ plasma. This embryo was about as far advanced as the one illustrated on plate 32, figure 4. The next day there was a median germinal strip of lighter cells and on one side a layer of decidedly darker cells, much as shown in plate 30, figure 1. February 1st the two layers described above were more distinct and broader, the median lighter one being crowded a little to one side by the greater development and consequent breadth of the darker ectoderm, which latter extended al-

most to the middle of the embryo and from its anterior third to its posterior fourth. The anterior extremity of the embryo is characterized by irregular series of moderately large cells in the germ plasm. February 2d the median mesodermal tissue was crowded still further to one side by the darker ectoderm which now extends to the middle of the embryo and appears to have elongated somewhat. Both extremities of the embryo have retracted a little from the tip of the amniotic sac and are occupied by irregular series of large cells. The following day the mesoderm was crowded still further to one side by the darker ectoderm. At the anterior extremity of the embryo there was a mass of rather dark, fine-celled tissue, possibly the corpus luteum and apparently separating by fission, while the greater portion appears to be composed of globular, highly refractive cells grouped much as at the posterior extremity, which latter is narrowly margined by rather large, highly refractive, indistinctly grouped cells, one or more being unusually large. February 4th there was a distinct clear space in each extremity of the amniotic sac. The anterior extremity of the embryo is distinctly lobed, the broader, less produced portion capped with a mass of large, refractive cells, the small protuberant lobe composed of fine tissue. The posterior extremity of the embryo is distinctly bilobed. Unfortunately the numerous changes observed in this embryo from this point on at least appear to be abnormal, since the embryo disintegrated February 9th, though pulsations in the mother larva continued normally till the 15th.

A very interesting embryo was discovered in larva *Y* February 6th. The embryo extended from the seventh to the eighth abdominal segments and had a length equal to nearly twice the diameter of the mother larva. It was narrowly elliptical, with a length approximately three times its diameter. The polar cells, though visible, were not so conspicuous as in the younger embryo illustrated on plate 30, figures 2 and 3. This embryo is composed of nearly uniformly developed, rather transparent, semicuboidal, ectodermal cells. At the anterior extremity there was a slight thickening, apparently the much reduced cells of the corpus luteum. The median portion was occupied by a rather broad streak of dark, granular cells bordered on either side, including the extremities, by lighter, smaller-celled tissue. The mother larva was alive, as evidenced by distinct pulsations. The following day a distinct though small cap of cells was observed at the anterior extremity of the embryo. At the posterior third of the embryo

there was a distinct constriction, almost a division, the tissues adjacent thereto being markedly larger and darker, while at the posterior extremity there was a distinct lobe occupying about two-thirds the width of the embryo. February 8th there was a shrinking from both extremities of the amniotic sac, and other changes which are not described in detail, since they appeared to be preliminary to disintegration the next day, though the mother larva continued alive until the 15th.

An active, moderate-sized, white larva was isolated February 27th and its granular ovaries were seen partially to divide into irregular lobes, the one at the posterior extremity of the left developing into an ovum larger than the remainder of the ovary. The anterior third of the ovum was filled with darker, granular matter, while the remainder consisted of clear plasm containing about seven large, nucleated cells. This ovum increased in size until it was larger than the remainder of the ovary in which it originated, gradually separating therefrom by fission and shortly developing into a small embryo in the morula stage with distinct polar cells much as is illustrated on plate 30, figures 2 and 3.

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EXPLANATION OF PLATES

PLATE 1

105

Codling moth work

Sprayed but once

1a Picked fruit: 135 sound, 13 wormy apples
1c Picked fruit: 382 sound, 27 wormy apples
1d Picked fruit: 563 sound, 30 wormy apples

Plate 1

Sprayed apples

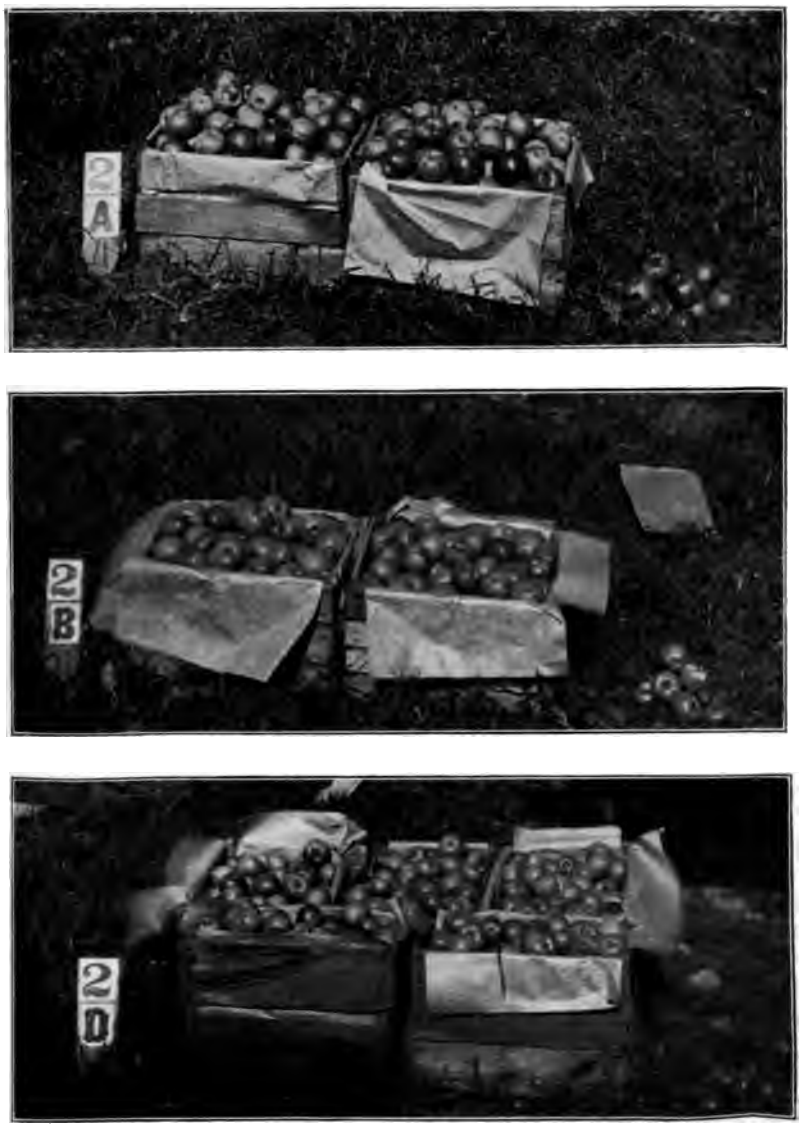
PLATE 2

Codling moth work

Sprayed twice

2a Picked fruit: 414 sound, 27 wormy apples
2b Picked fruit: 347 sound, 15 wormy apples
2d Picked fruit: 941 sound, 13 wormy apples

Plate 2



Sprayed apples

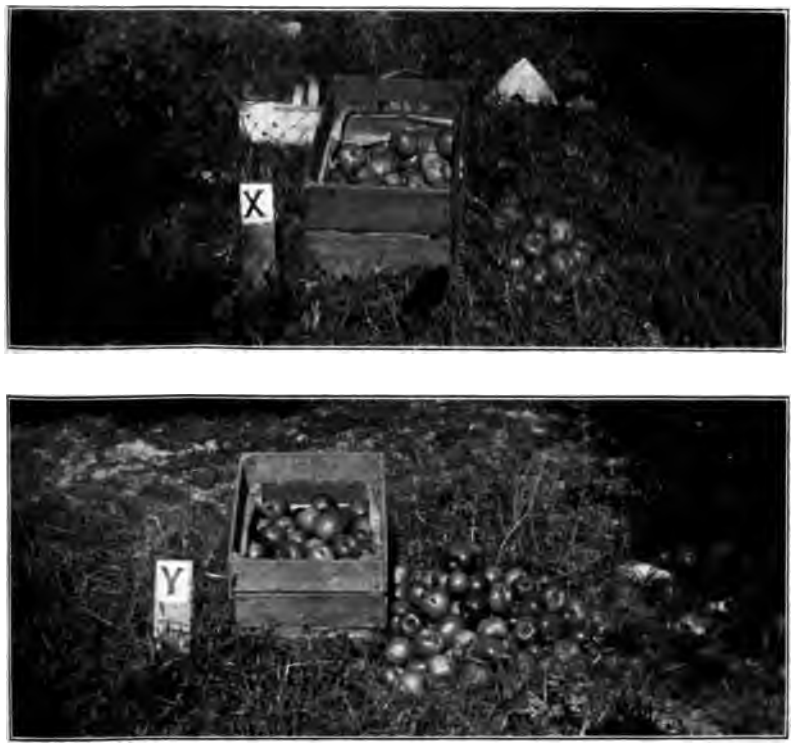
PLATE 3

Codling moth work

Unsprayed or check trees

X Picked fruit: 86 sound, 69 wormy apples
Y Picked fruit: 97 sound, 233 wormy apples

Plate 3



Unsprayed apples

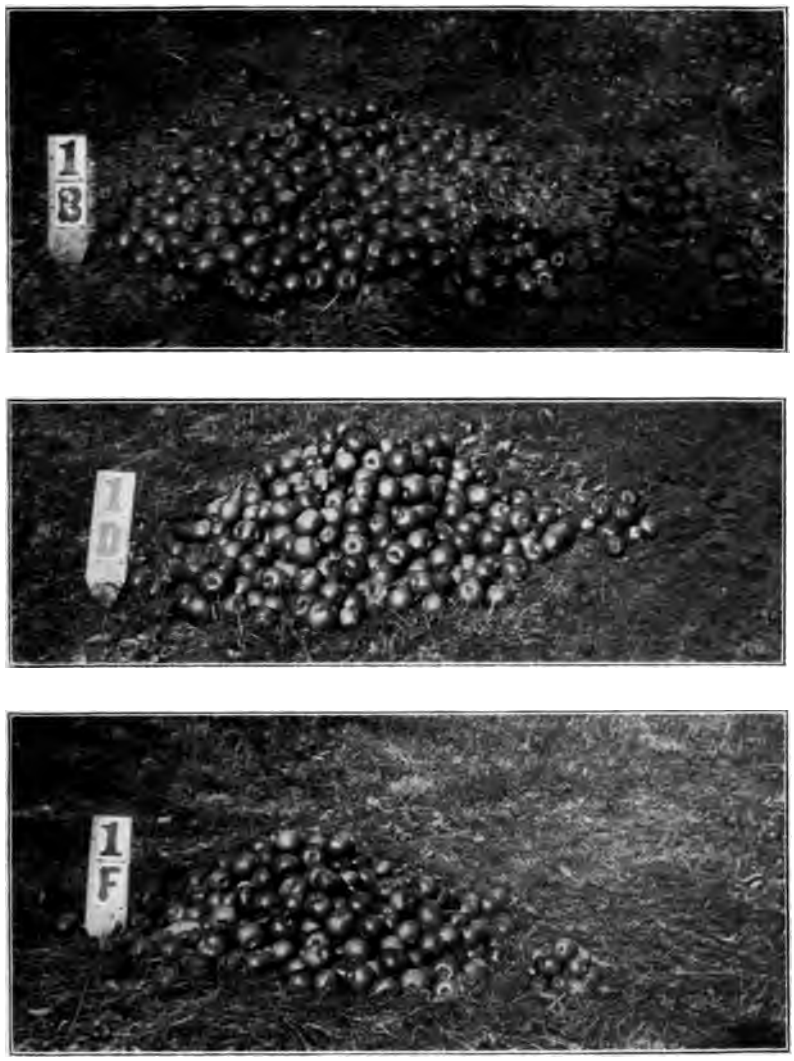
PLATE 4

III

Codling moth work

		Sprayed but once
1*b*	Picked fruit:	1304 sound, 117 wormy apples
1*d*	Picked fruit:	703 sound, 82 wormy apples
1*f*	Picked fruit:	596 sound, 63 wormy apples

Plate 4



Sprayed apples

PLATE 5

113

PLATE 3

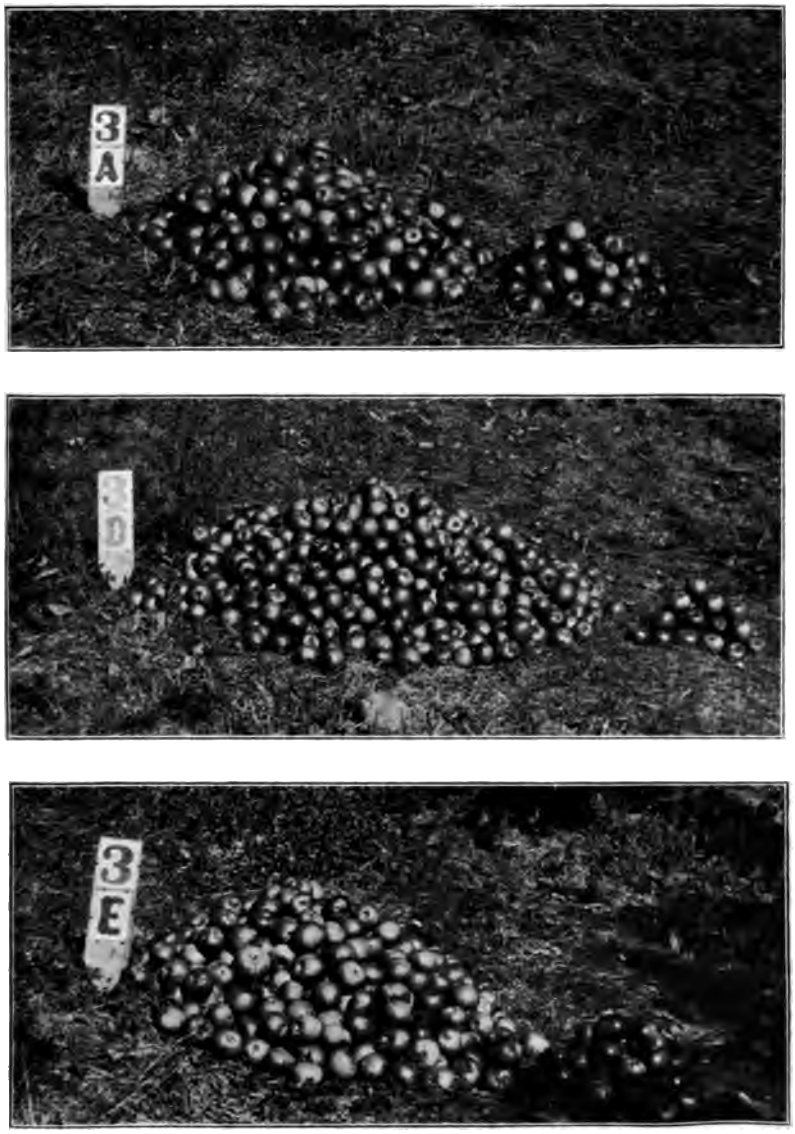
PLATE 6

Codling moth work

One late spraying

3*a* Picked fruit: 392 sound, 198 wormy apples
3*d* Picked fruit: 830 sound, 128 wormy apples
3*c* Picked fruit: 467 sound, 163 wormy apples

Plate 6



Sprayed apples

PLATE 7

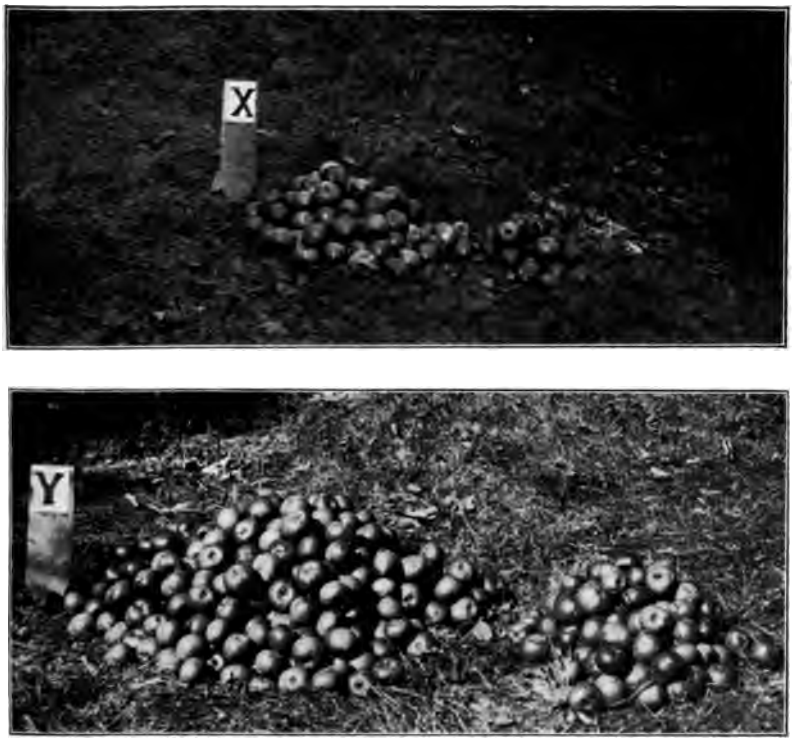
117

Codling moth work

Unsprayed or check trees

X Picked fruit: 120 sound, 47 wormy apples
Y Picked fruit: 317 sound, 325 wormy apples

Plate 7



Unsprayed apples

PLATE 8

PLATE 6

PLATE 9

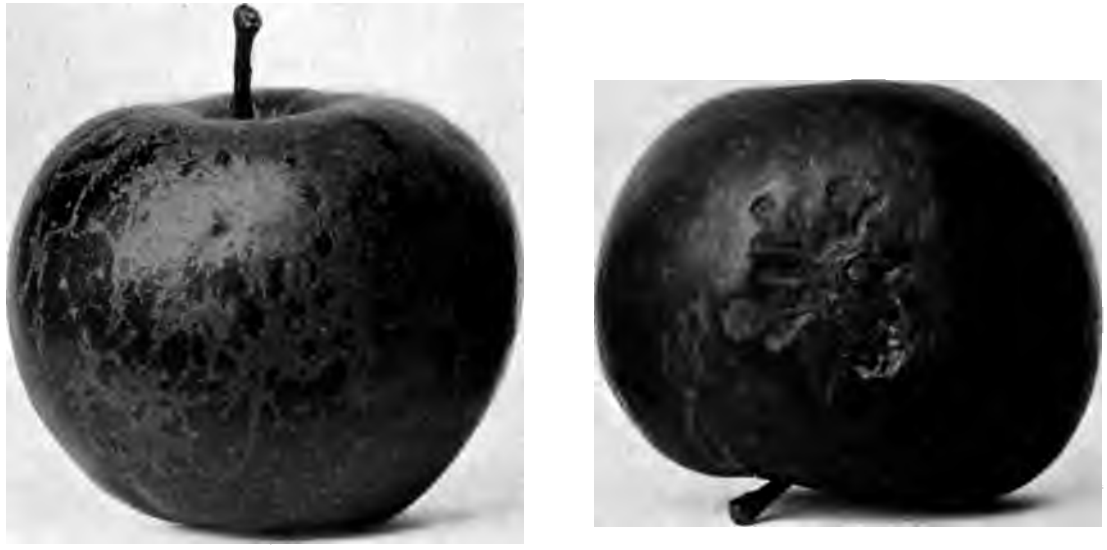
121

Wormy apples

PLATE 10

Codling moth work

1 Baldwin showing a moderate amount of bordeaux injury
2 Work of Tortricid followed by codling moth injury



Russeted and wormy fruit

PLATE 11

Codling moth work

Two apples showing work of Tortricid

1 The operations of the insect about the blossom end
2 Its feeding near the end and upon the side of the apple

Work of Tortricid on apples

PLATE 12

Plate 12

Russeting and codling moth injury

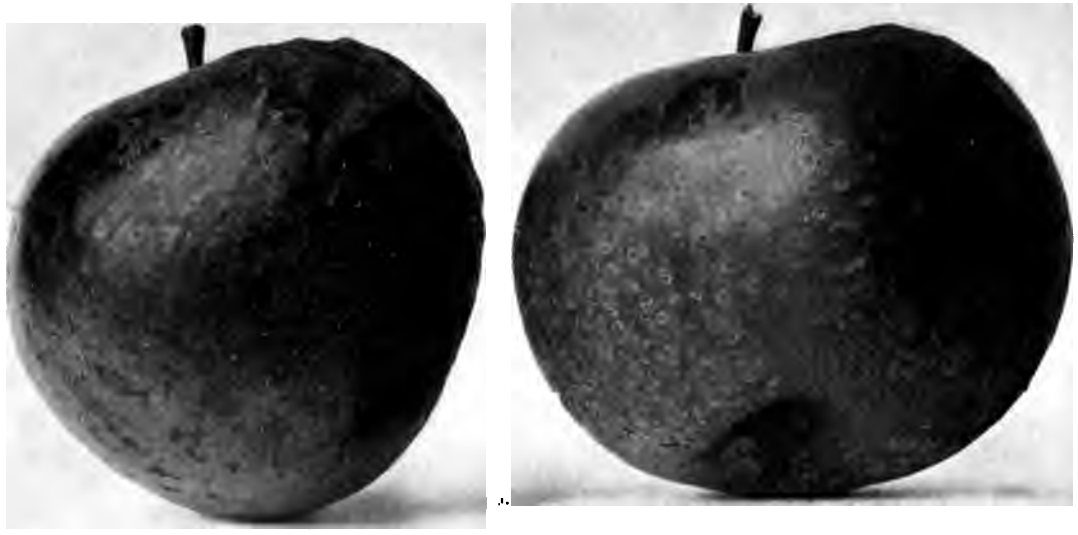
PLATE 13

Codling moth work

1 Asymmetrical Ben Davis with one side badly deformed, probably f injury by bordeaux mixture

2 Another apple badly injured though not deformed by bordeaux mix

Plate 13

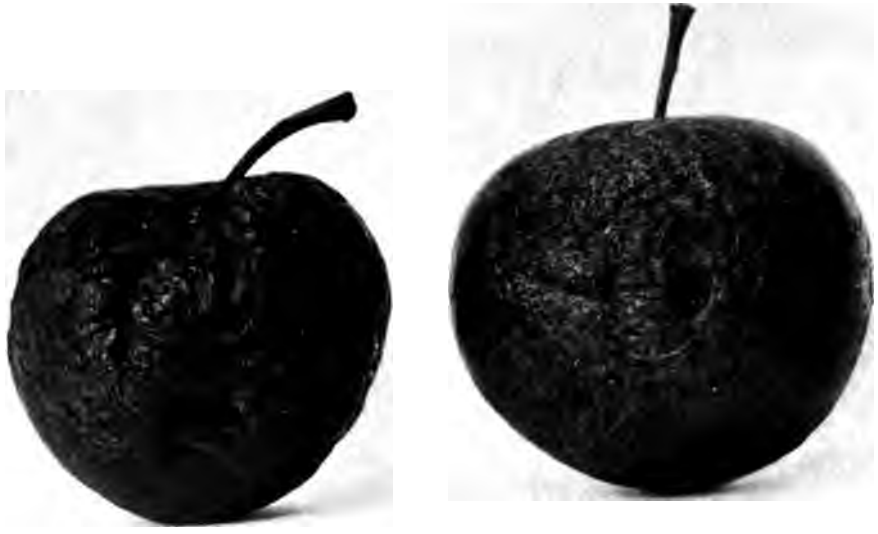


Russeted fruit

PLATE 14

131

4a



Russeted and checked fruit

PLATE 15

Plate 15

Work of ash psylla

PLATE 16

Psyllopsis fraxinicola Först.

1 Anterior wing, male. x 15
2 Posterior wing, male. x 15
3 Apex of male abdomen, showing genitalia. x 20
4 Apex of female abdomen, showing ovipositor and accessory organs
5 Head. x 15
6 Antenna, portion of anterior leg and part of rostrum of female. x 3

Plate 16

1

2

3

5

4

6

Ash psylla

PLATE 17

137

1 Gall of Chermes cooleyi Gill. on blue spruce, natural size
2 A portion of a printed page showing a crane fly which had been pressed into the paper in the calendering process. Natural size

PLATE 15

133

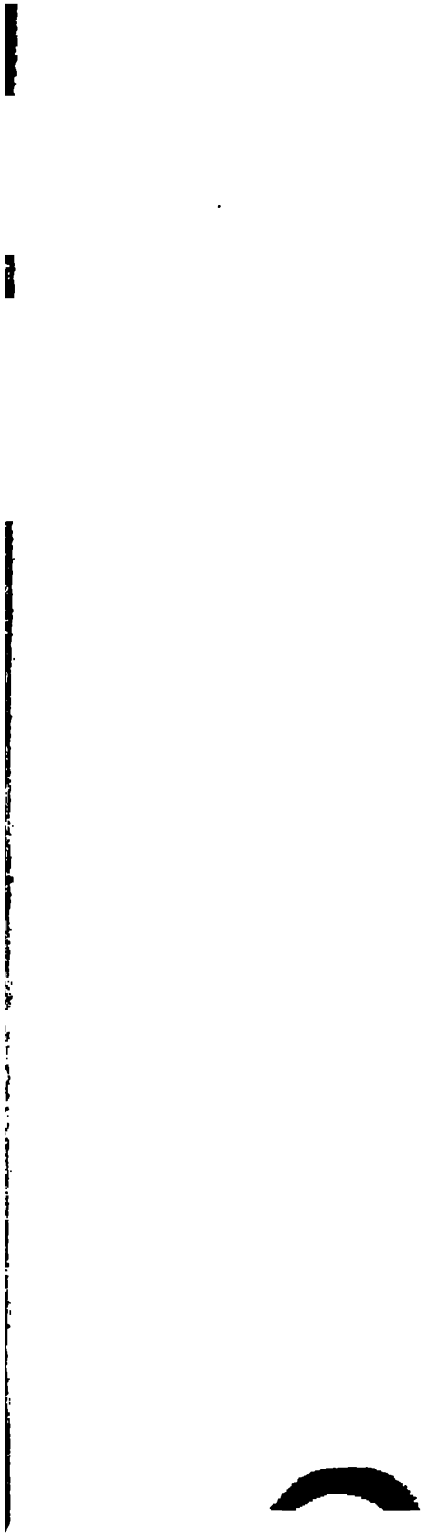


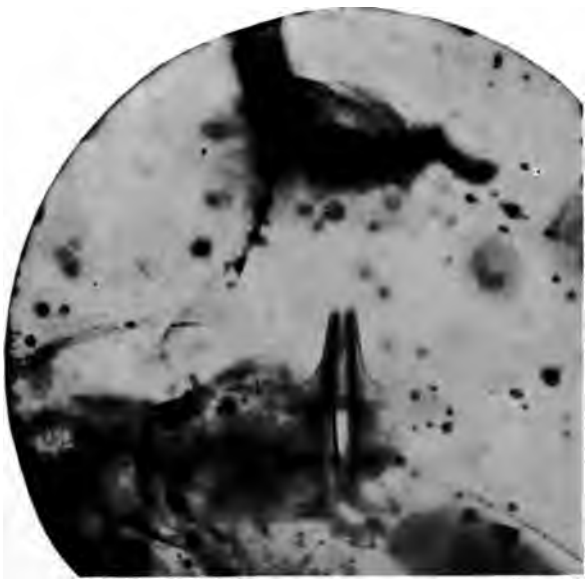
PLATE 18

Chermes piceae Ratz.

1 Ventral aspect of female. x 35
2 Posterior extremity showing ovipositor. x 200

Plate 18

1



2

Silver fir aphid

PLATE 19

Camponotus herculeanus Linn.

Work of carpenter ant in poplar

142

PLATE 17

137

PLATE 20

143

Camponotus herculeanus Linn.

Work of carpenter ant in poplar; another view

144

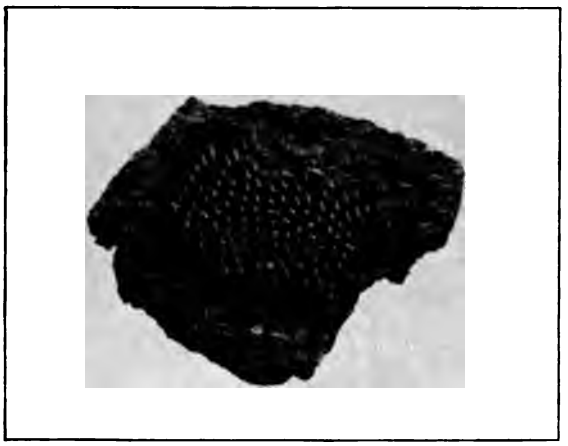
Plate 20

Work of carpenter ant

PLATE 21

145

Plate 21



1

2

Snow-white linden moth

PLATE 22

147

Miastor ? americana Felt

1 Large, white, living larva chilled. Photographed by **reflected light.**

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PLATE 20

PLATE 23

Miastor ? americana Felt

1 Mother larva containing a number of semitransparent embryos. Note cells well filled with adipose tissue. x 50. By reflected light

2 Mother larva containing several semitransparent embryos. Note comparatively few large cells filled with adipose tissue. x 50. By reflected light

PLATE 21

145

PLATE 24

151

PLATE 25

153

Miastor ? americana Felt

Posterior extremity of a large mother larva filled with numerous embr
one lying free across the broken end. x 100

Plate 25

Miastor embryos

Miastor ? americana Felt

Posterior extremity of a large mother larva filled with numerous
one lying free across the broken end. x 100

154

Plate 25

Miastor embryos

PLATE 26

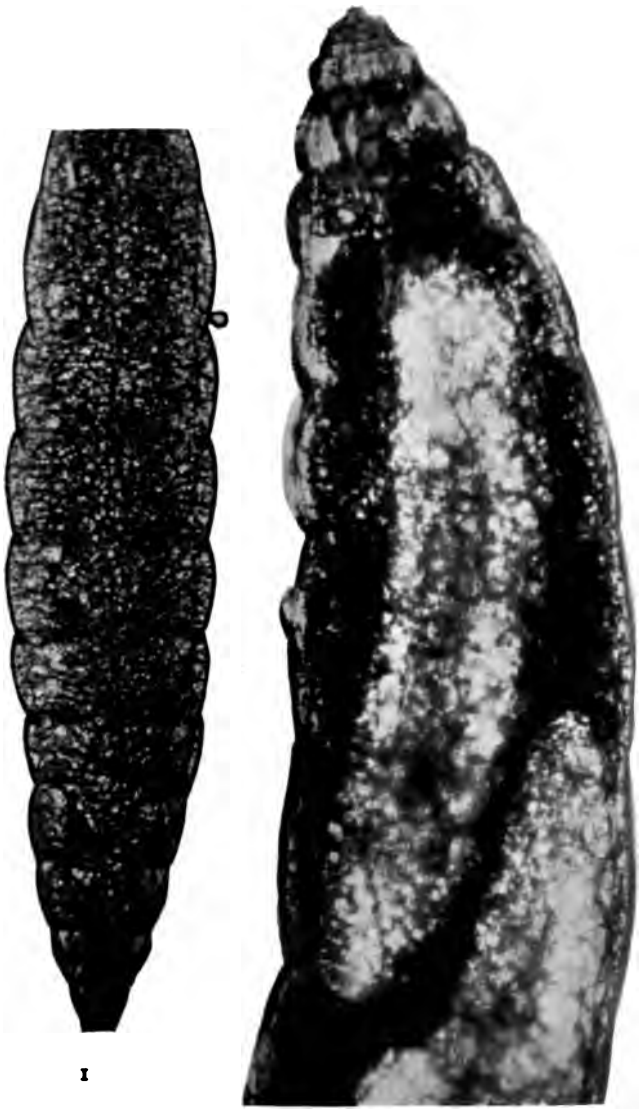
155

PLATE 24

PLATE 27

157

Plate 27



1

2

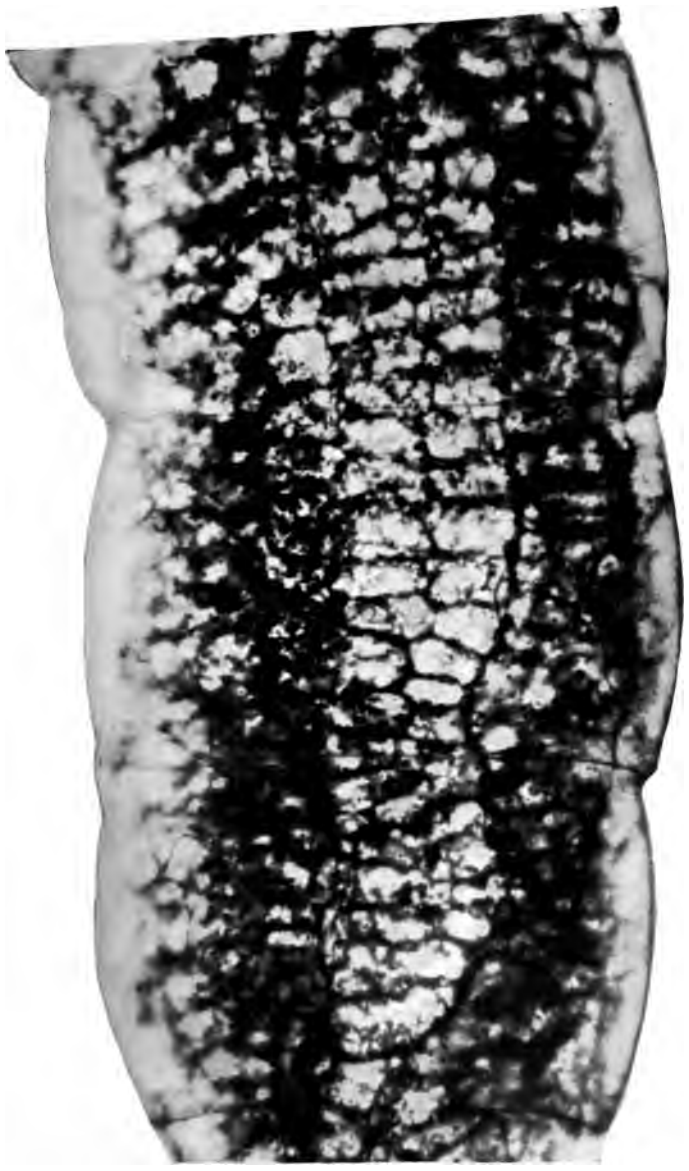
Miastor larvae

PLATE 28

Miastor ? americana Felt

Three segments of a large, white mother larva, showing series of cubical cells. x 200

Plate 28



Portion of Miastor larvae

PLATE 29

161

Plate 29

1

Miastor larvae 2

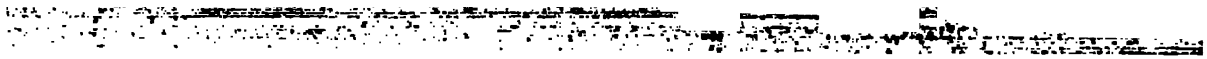


PLATE 30

163

5

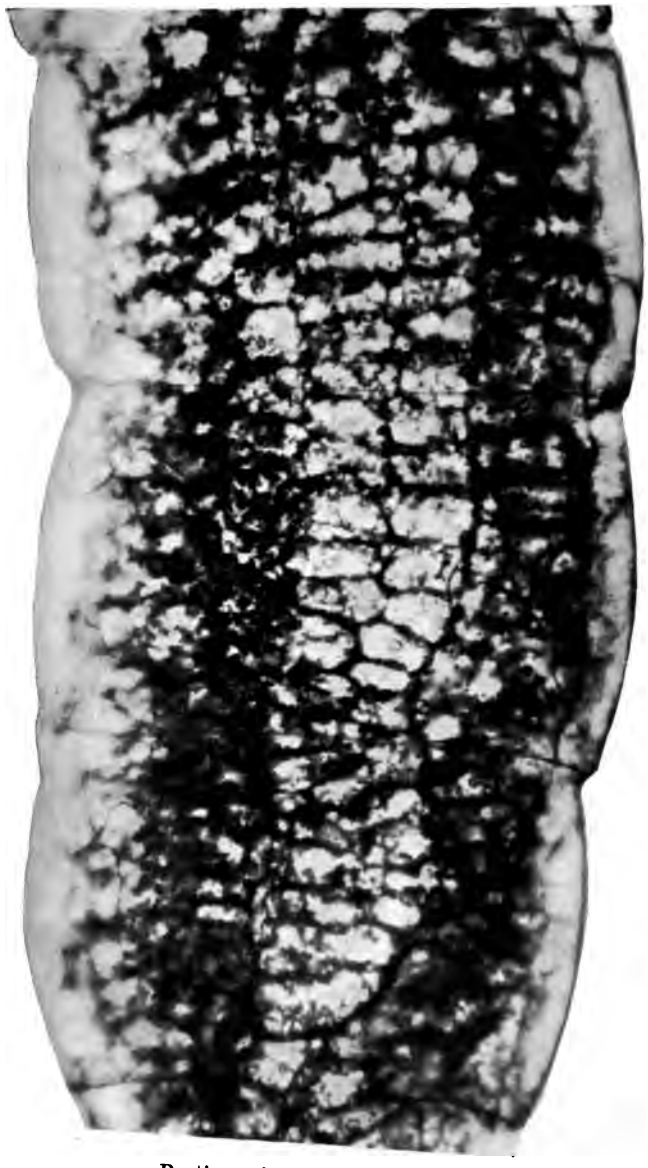
Plate 30

1

2

Miastor embryos 3

Plate 28



Portion of Miastor larvae

Miastor ? americana Felt

1 Anterior extremity of embryo illustrated in figure 1 of the precedi
x 300

2 Middle portion of same embryo. x 300

PLATE 29

161

PLATE 32

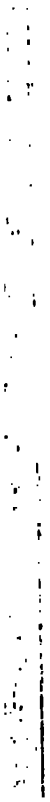


Plate 32

1

2

3

4

5

Miastor embryos

PLATE 33

Plate 33

1

2

3

Miastor embryos

PLATE 34

Miastor ? americana Felt

1 Small, yellowish mother larva containing an embryo extending from the fourth to the eleventh body segments and illustrating an early stage in the development of the mesoderm and adipose tissue. x 75

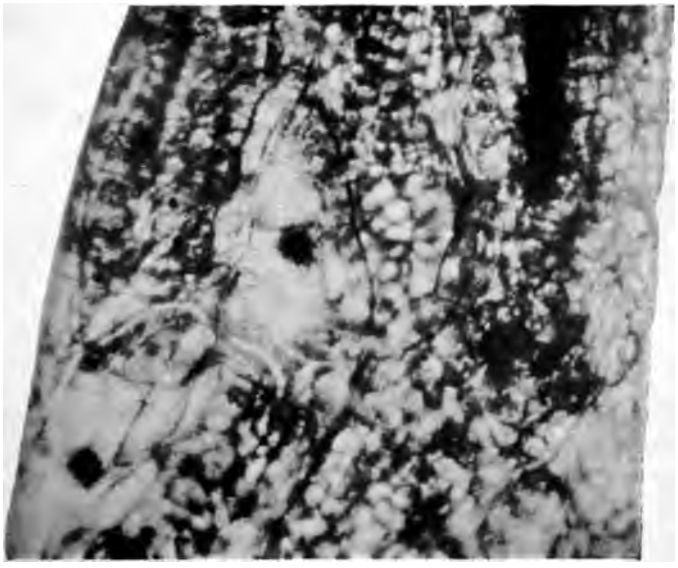
2 Small, somewhat shrunken, yellowish mother larva containing a nearly fully developed embryo, the fuscous anterior portion of the head and the black ocular spot showing distinctly in her posterior (lower) body segments. x 75

3 Portion of a large, white mother larva packed with numerous embryos. The two conspicuous black spots near the middle of lighter areas represent well developed ocular spots of embryos nearly ready to escape. This mother larva contained about 10 such embryos, the heads of three at least, being included in the portion illustrated. x 200

Plate 34

1

2



3

Miastor embryos

Plate 32

1

2

3

4

5

Miastor embryos

Plate 35

1

2

3

Miastor embryos

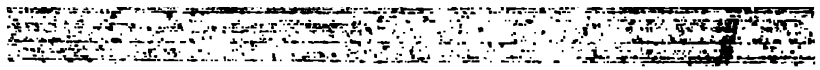
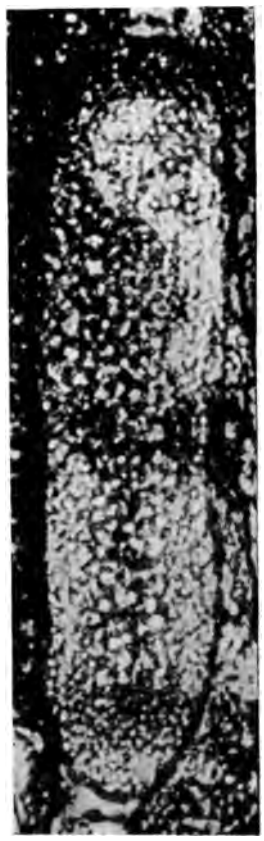


Plate 33

1

2



3

Miastor embryos

PLATE 34

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Miastor ? americana Felt

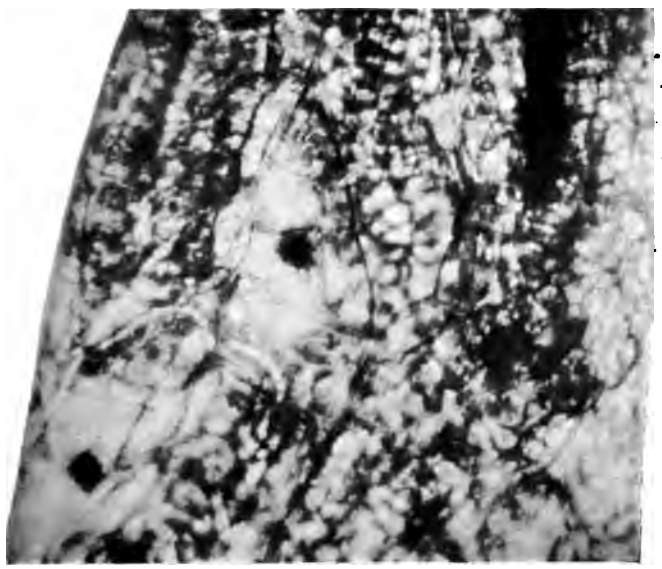
1 Small, yellowish mother larva containing an embryo extending from the fourth to the eleventh body segments and illustrating an early stage in the development of the mesoderm and adipose tissue. x 75

2 Small, somewhat shrunken, yellowish mother larva containing a nearly fully developed embryo, the fuscous anterior portion of the head and the black ocular spot showing distinctly in her posterior (lower) body segments. x 75

3 Portion of a large, white mother larva packed with numerous embryos. The two conspicuous black spots near the middle of lighter areas represent well developed ocular spots of embryos nearly ready to escape. This mother larva contained about 10 such embryos, the heads of three at least, being included in the portion illustrated. x 200

Plate 34

1 2



3
Miastor embryos

PLATE 35

Miastor ? americana Felt

1 Mother larva containing an embryo extending from about the fifth to the tenth body segments and showing an early stage in the development of the mesodermal tissue. x 100. A portion of the latter more enlarged as illustrated on plate 33, figure 1.

2 Small, yellow mother larva containing an embryo extending from the fourth to the twelfth segments and showing in the posterior part of the embryo a conspicuous mass of large-celled mesodermal tissue with distinctly rounded extremities. x 100

3 Small, yellow mother larva containing a nearly developed embryo showing the three-rowed condition due to an increase in the embryonic adipose tissue and a correlated decrease in the mesoderm. x 100

All on this plate are arranged with the head of the mother larva up, the anterior extremity of the embryo being toward the bottom of the plate.

Bulletins are also found with the annual reports of the museum as follows:

Bulletin	*Report*	*Bulletin*	*Report*	*Bulletin*	*Report*	*Bulletin*	*Report*
12–15	48, v. 1	72	57, v. 1, pt 2	102	59, v. 1	134	62, v. 2
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32–34	54, v. 1	77	57, v. 1, pt 1	109,110	60, v. 1	139	63, v. 2
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37–44	54, v. 3	79	57, v. 1, pt 2	112	60, v. 1	141	63, v. 2
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55	56, v. 4	83,84	58, v. 1	115	60, v. 2		
56	56, v. 1	85	58, v. 2	116	60, v. 1	*Memoir*	
57	56, v. 3	86	58, v. 5	117	60, v. 3	2	49, v. 3
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70,71	57, v. 1, pt 1	101	59, v. 2	133	62, v. 1	13	63, v. 4

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Geology. 14 Kemp, J. F. Geology of Moriah and Westport Townships, Essex Co. N. Y., with notes on the iron mines. 38p. il. 7pl. 2 maps. Sept. 1895. Free.

19 Merrill, F. J. H. Guide to the Study of the Geological Collections of the New York State Museum. 164p. 119pl. map. Nov. 1898. *Out of print.*

21 Kemp, J. F. Geology of the Lake Placid Region. 24p. 1pl. map. Sept. 1898. Free.

48 Woodworth, J. B. Pleistocene Geology of Nassau County and Borough of Queens. 58p. il. 8pl. map. Dec. 1901. 25c.

56 Merrill, F. J. H. Description of the State Geologic Map of 1901. 42p. 2 maps, tab. Nov. 1902. Free.

77 Cushing, H. P. Geology of the Vicinity of Little Falls, Herkimer Co. 98p. il. 15pl. 2 maps. Jan. 1905. 30c.

83 Woodworth, J. B. Pleistocene Geology of the Mooers Quadrangle. 62p. 2 5pl. map. June 1905. 25c.

84 —— Ancient Water Levels of the Champlain and Hudson Valleys. 206p. il. 11pl. 18 maps. July 1905. 45c.

95 Cushing, H. P. Geology of the Northern Adirondack Region. 188p. 15pl. 3 maps. Sept. 1905. 30c.

96 Ogilvie, I. H. Geology of the Paradox Lake Quadrangle. 54p. il. 17pl. map. Dec. 1905. 30c.

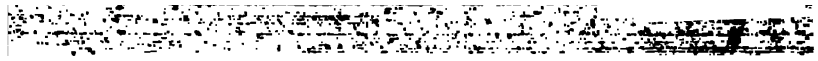
106 Fairchild, H. L. Glacial Waters in the Erie Basin. 88p. 14pl. 9 maps. Feb. 1907. *Out of print.*

107 Woodworth, J. B.; Hartnagel, C. A.; Whitlock, H. P.; Hudson, G. H.; Clarke, J. M.; White, David & Berkey, C. P. Geological Papers. 388p. 54pl. map. May 1907. 90c, *cloth.*

Contents: Woodworth, J. B. Postglacial Faults of Eastern New York.
Hartnagel, C. A. Stratigraphic Relations of the Oneida Conglomerate.
—— Upper Siluric and Lower Devonic Formations of the Skunnemunk Mountain Region.
Whitlock, H. P. Minerals from Lyon Mountain, Clinton Co.
Hudson, G. H. On Some Pelmatozoa from the Chazy Limestone of New York.
Clarke, J. M. Some New Devonic Fossils.
—— An Interesting Style of Sand-filled Vein.
—— Eurypterus Shales of the Shawangunk Mountains in Eastern New York.
White, David. A Remarkable Fossil Tree Trunk from the Middle Devonic of New York.
Berkey, C. P. Structural and Stratigraphic Features of the Basal Gneisses of the Highlands.

111 Fairchild, H. L. Drumlins of New York. 60p. 28pl. 19 maps. July 1907. *Out of print.*

115 Cushing, H. P. Geology of the Long Lake Quadrangle. 88p. 20pl. map. Sept. 1907. *Out of print.*



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New York State Museum

JOHN M. CLARKE, Director

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The divisions to which bulletins belong are as follows:

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2 Botany
3 Economic Geology
4 Mineralogy
5 Entomology
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7 Economic Geology
8 Botany
9 Zoology
10 Economic Geology
11 "
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New York State Museum

JOHN M. CLARKE, Director

FREDERICK PETER FELT, State Entomologist

Museum Bulletin 155

27th REPORT OF THE STATE ENTOMOLOGIST

ON

INJURIOUS AND OTHER INSECTS

OF THE

STATE OF NEW YORK

1911

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New York State Education Department
Science Division, December 26, 1911

***Hon.** Andrew S. Draper LL.D.*
Commissioner of Education

Sir: I have the honor to communicate herewith the annual report of the State Entomologist for the fiscal year ending September 30, 1911, and to recommend the same for publication.

Very respectfully
JOHN M. CLARKE
Director

STATE OF NEW YORK
EDUCATION DEPARTMENT
COMMISSIONER'S ROOM

***Approved** for publication this 26th day of December 1911*

A. S. Draper

Commissioner of Education

Education Department Bulletin

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No. 510 ALBANY, N. Y. JANUARY 1, 1912

New York State Museum

JOHN M. CLARKE, Director

EPHRAIM PORTER FELT, State Entomologist

Museum Bulletin 155

27th REPORT OF THE STATE ENTOMOLOGIST, 1911

Dr John M. Clarke, Director of Science Division

I have the honor of presenting herewith my report on the injurious and other insects of the State of New York for the year ending September 30, 1911.

The appearance in late May of a large brood of the periodical Cicada or so-called seventeen-year locust was of great popular interest and an entomological event of some importance. A hitherto unknown colony was located near Amsterdam and through the cooperation of many local observers much was learned respecting the present distribution and relative abundance of this insect in New York State. A fine series of photographs showing the transformations to the adult was obtained. Despite the warnings of earlier years, a number of young orchard trees had been set in the vicinity of populous Cicada colonies and, as a result, were severely injured. A detailed notice of this unique form is given on subsequent pages.

During the period covered by this report, Miastor larvae were discovered, their biology ascertained in large measure, their amenability to laboratory conditions demonstrated, and owing to the value of this information to teachers, a discussion of pedogenesis in this insect and its allies was included in an appendix to the Entomologist's report for 1910. Subsequent studies have confirmed the observations referred to above and have shown a wide distribution for Miastor.

Fruit pests. The experiments with the codling moth or apple worm were continued in the orchard of Mr W. H. Hart of Poughkeepsie and in those of Messrs Edward Van Alstyne and

William Hotaling at Kinderhook. Special pains were taken to secure uniform plots of ample size and to see that the treatment was thorough. Each plot, as last year, except in the case of Mr Hotaling's orchard, consisted of forty-two trees, the fruit from the central six alone being counted. The relative value of one, two and three sprayings, and also of one application made three weeks after the blossoms dropped, was ascertained. The results compare closely with those obtained in 1909 and go far to show that the conditions in 1910 were exceptional. One thorough application last season resulted, in the case of trees bearing a fair crop, in from over 98 to more than 99 per cent of worm-free fruit. This should prove most encouraging to the fruit grower, since the work was done under practical conditions which can be duplicated in almost any section. Assistant State Entomologist Young assisted in the field work, classified the wormy fruit and computed the tabulated data.

The work of 1911 with the codling moth has been correlated with that of the two preceding years and is the most comprehensive data yet secured as to the possibilities with one spraying under varied conditions. These results should be of great practical value in enabling the fruit grower to determine for himself the advisability of spraying for this pest more than once in any season. The details are given on subsequent pages.

Observations show that the San José scale, while a serious fruit tree pest, is being generally controlled, though some fruit growers are not entirely successful, due in large measure to difficulties in treatment. Some of these are excessively large or inaccessible trees, adverse weather conditions at the time the work should be done or defects in equipment. The concentrated home-made or commercial lime-sulfur washes were used largely and mostly with very satisfactory results.

The peculiar linear series of eggs so frequently seen on apple and pear bark have been identified as those of the notch wing, a species noticed below. The usually rare Say's blister beetle was exceptionally numerous. Two small fruit insects, the raspberry Byturus and the garden flea, were studied at Milton, the former proving somewhat injurious.

Gipsy moth. The discovery of a gipsy moth colony at Lenox, Mass., while not entirely unexpected, was something of a shock to our extensive agricultural interests. A personal examination satisfied the Entomologist that the insect was

brought there with trees and shrubs purchased a few years ago in eastern Massachusetts. A small colony was discovered later at Great Barrington, Mass. Nothing but the closest inspection and the adoption of most rigid precautions will prevent the early establishment of this pest in New York State. Judged solely from an economic standpoint, there can be no question as to the advisability of keeping this insect out of the State as long as possible. We have assembled during the year a series of preparations designed to facilitate the recognition of this pest in any stage. Several of these have been reproduced as photomicrographs and will be of great service in identifying this species.

The Entomologist visited the territory in eastern Massachusetts infested by this insect and found the residential area, as a whole, in excellent condition though there were extensive tracts of forest land badly infested. The ultimate spread of this pest is inevitable. The Federal authorities have accomplished much in retarding its dissemination by keeping the roadside trees of the principal thoroughfares free of caterpillars. Marked progress is being made in the work of introducing parasites and natural enemies which it is expected will shortly prove of material service in checking this destructive insect. The latter is no justification for not adopting every reasonable measure for preventing the spread of this dangerous enemy. The state of Connecticut has made excellent progress in handling its gipsy moth problem. This insect is more fully considered below.

Brown-tail moth. This species, while not so destructive as the gipsy moth, has become established in North Adams, Mass. and smaller infestations occur at Adams and Williamstown, Mass. Since both sexes of the moth fly readily, it will probably not be long before this pest appears somewhere in New York State. The winter nests are so characteristic that there should be little difficulty in identifying the insect and at the outset preventing excessive multiplication. Careful inspection of nursery stock should prove a most effective barrier to its being introduced with trees and shrubs. The observations above relating to the parasites of the gipsy moth apply equally to the natural enemies of the brown-tail moth.

Shade tree pests. The Entomologist investigated conditions in a number of communities and found exceptionally severe and widespread injury by the elm leaf beetle. The defoliation was so general, in connection with the work of previous years

and the severe droughts of earlier seasons, that many trees have succumbed or are likely to perish in the next few years unless radical measures are adopted for their better protection.

There seems to be great difficulty in securing efficient treatment, even if the equipment be adequate. This defect has been pointed out and, with a fuller understanding on the part of those compelled to solve the problem, we look for materially better results another season. The elm leaf beetle is not such a serious pest in Europe, and it would seem, in view of the probable continuance of the severe injury of the last few years, due in part at least to changed conditions, as though a serious effort might well be made to secure natural enemies, since they appear to be very effective checks upon this beetle in European countries.

The cottony maple scale and the false maple scale occasioned repeated complaints, because of serious injury to hard and soft maples, especially in the vicinity of New York City. An unfortunate condition developed in the city of Mount Vernon. Several hundred hard or sugar maples were seriously injured or killed, following the application of one of the commercial miscible oils in early spring. An investigation convinced the Entomologist that the trouble was due to the material applied, the injury being greatly aggravated by subsequent cold weather retarding growth and producing conditions favorable for penetration by the oil. We must therefore classify early applications of oily preparations as dangerous to hard maples. Our findings are given in detail below.

The extended outbreak by the green maple worm was investigated and must be partly charged to the general destruction of birds and a consequent scarcity of the insectivorous species. Investigations by Zoologist W. G. Van Name showed that nine species were feeding upon the caterpillars, while nine others were in the vicinity, probably for the same purpose. A relatively slight increase in the number of birds would doubtless have prevented the defoliation of the trees. A detailed account of this insect is given in subsequent pages. The spiny elm caterpillar and the white-marked tussock moth are two other shade tree pests which were excessively abundant and the subjects of much correspondence. The ornamental birches are being rapidly destroyed by the pernicious bronze birch borer, the depredations of which were detected the past season in the eastern part of the State.

Forest pests. Injuries by insects to forests have greatly increased during recent years. The hickory bark borer has destroyed thousands of magnificent trees in the vicinity of New York. The investigations of the Entomologist showed that this nefarious pest had destroyed many hickories at Tivoli. A warning circular was issued and widely copied by the local press. The two-lined chestnut borer, probably breeding first in fungous-affected chestnut, invaded nearby oaks at Old Westbury. This outbreak was studied and appropriate repressive measures advocated. Damage by this species was also reported from Garden City. The severe though local injury by the locust leaf beetles at Syosset and Jericho received personal attention and is fully discussed on subsequent pages. The exceptional abundance of the maple leaf cutter at Lake George was also investigated, and an account is given below.

Flies and mosquitos. General interest has been maintained in the house fly campaign. The Entomologist prepared several popular notices and experimented in a limited way with a fly trap. The results with the latter, while beneficial, were not entirely convincing. We investigated a local mosquito problem at South Salem and had the satisfaction of learning that the execution of our recommendations resulted in the speedy disappearance of the pests. Many localities in the State are suffering needless annoyance and, in some cases, illness because mosquito breeding pools are ignored. One case came to our notice where malaria developed following the employment of Italians in a locality previously free from this disease.

Gall midges. Our studies in this interesting and important group have been continued as opportunity offered. A number of new species have been reared and described, and a table of food habits of the reared species and a generic synopsis of the entire group published. This family, composed entirely of small to minute flies and including a number of destructive forms, is an immense complex which could be grouped satisfactorily only after prolonged and careful microscopic studies. This has been accomplished and a monographic account of the family is now in manuscript.

Publications. A number of brief popular accounts of the more injurious species of the year were prepared and widely circulated through the agricultural and local press. The extended contributions, aside from the report for last year, are: *Summary*

of the Food Habits of American Gall Midges; A Generic Synopsis of the Itonidae; Hosts and Galls of American Gall Midges; and *New Species of Itonidae.* A list of the more important publications of the Entomologist, forty-four in number, is given below.

Collections. There has been a continued increase in the State collections. Most of the additions the past year have resulted from collections by the office staff, some of the most desirable having been reared. Extremely large series of Miastor and Oligarces were obtained in this manner and will later be available for exchange. Specimens illustrating the habits and work of insects are being collected at every opportunity, since they are particularly valuable for economic and exhibition purposes. There have been substantial additions to the gall midges or Itonidae and they are now in very satisfactory condition. The pinned specimens were rearranged by Miss Hartman and this, in connections with the numerous microscopic slides, and the large assemblage of galls and other biological material, will prove invaluable to subsequent workers, especially as the collection includes a very large number of types.

The classification of the diversified material in the Museum and that daily coming to hand is necessarily slow and is a work which must extend over years. There is need of more assistance in carrying on the large amount of labor involved in the amassing of a thoroughly representative collection necessary for the maintenance of an adequate exhibit in the enlarged quarters afforded by the new Education Building.

Three additions have been made to the series of plant groups designed for the exhibition of insects in their natural environment. These will add greatly to the attractiveness and pedagogical value of the enlarged exhibit collections now in preparation.

Assistant State Entomologist Young has rearranged and identified the Muscidae, the species belonging to the Coleopterous genera Telephorus and Podabrus, and has done considerable on the snapping beetles or Elateridae, the parasitic flies, the Tachinidae, and a group of parasitic wasps, the Braconidae.

Miss Hartman made nearly five hundred microscopical preparations of various species, mostly gall midges and scale insects, rearranged the pinned collection of scale insects and prepared a special Cicada exhibit. She also gave much time to mounting, spreading and labeling of specimens.

Nursery inspection. The nursery inspection work conducted by the State Department of Agriculture has resulted in the office being requested to make numerous identifications and also recommendations in regard to the policy which should be pursued by the State. Most of the material submitted for name is in poor condition, may represent any stage in insect development, and is often from a foreign country. This work, though time-consuming and laborious, is very important, since the disposition of large shipments of nursery stock must depend in great measure upon our findings. The possibility of introducing the gipsy and brown-tail moths with stock originating in territory infested by these pests, justifies a most careful examination of all such material and the adoption of every reasonable precaution.

Miscellaneous. A series of experiments, conducted to test the value of heat as an insecticide, showed that the relatively moderate temperature of 120° F. is soon fatal to the common black cockroach so frequently seen in warmer parts of dwellings. Buildings equipped with ample heating facilities are adapted to this method of checking household and storeroom pests. A series of observations were made upon the hibernation and development of the rose leaf hopper. An interesting outbreak by an Iris borer was also investigated. These two insects are discussed more fully on subsequent pages. Assistant State Entomologist Young had charge of the heat experiments, being assisted in this by Miss Hartman.

The Entomologist, as in previous years, has been called upon to lecture upon injurious insects at farmers institutes, horticultural and other gatherings. Information respecting shade tree pests, owing to their serious injuries this year, was most frequently desired.

Office matters. The general work of the office has progressed in a satisfactory manner. The Assistant State Entomologist was in charge of the office and responsible for the correspondence and other matters during the absence of the Entomologist. Miss Hartman, in addition to matters noted above, made a large colored chart of the elm leaf beetle, rendered material assistance in various aspects of the experimental work, cared for breeding jars, compiled bibliographies and translated a number of excerpts from scientific articles. Numerous specimens have been received for identification during the year and many inquiries made concerning injurious forms. The correspondence

shows a marked increase over that of last year; 2219 letters, 23 postals, 1014 circulars, 1623 packages were sent through the mails and 42 packages were shipped by express.

General. The work of the office has been greatly facilitated, as in past years, by the identification of certain species through the courtesy of Dr L. O. Howard, Chief of the Bureau of Entomology, United States Department of Agriculture, and his associates. Several correspondents have aided materially in securing valuable specimens and many rendered efficient service by transmitting local data respecting various insects. As heretofore, there has been a most helpful cooperation on the part of all interested in the work of this office.

Respectfully submitted

EPHRAIM PORTER FELT
State Entomologist

October 14, 1911

INJURIOUS INSECTS

CODLING MOTH

Carpocapsa pomonella Linn.

Plates 1–7

The work of the last two years with this important pest of the fruit grower has been continued and some extremely interesting data secured. Even one spraying resulted in obtaining 98 to 99 per cent of sound fruit, while the check trees yielded only 67 and 85 per cent of worm-free apples. The second and third poison applications increased the percentage of sound fruit comparatively little. These results confirm those secured in 1909 and go far toward showing the possibility of a thorough, timely spraying. The low efficiency of the one application made three weeks after the falling of the blossoms, determined last year as approximately one-half that of a timely application, was confirmed this season by experiments in two orchards under diverse conditions.

Life history and habits. The discussion of the experimental data may well be preceded by a brief summary of the life history of this species. The codling moth or apple worm, as is well known, winters in a tough, silken cocoon usually found under the rough bark of trees. The appearance of warm weather in the spring, which in New York means late April and early May, is followed by the caterpillars transforming within their silken retreats to the brown, apparently lifeless pupae, and a week or ten days after the blossoms drop, the moths commence to emerge and continue to appear throughout the greater part of June. The minute, whitish eggs are deposited largely upon the leaves though a number may be found on the young fruit. These hatch in about a week and as a consequence the young apple worms of the first brood may be entering the small fruit from early in June, approximately three weeks after the blossoms fall, to nearly the end of the month or even later. The caterpillars require about four weeks to complete their growth, at which time they desert the fruit, wander to a sheltered place, spin a cocoon, transform once more to pupae and in about two weeks, namely, the last of July or in August,

another brood of moths may appear. These in turn deposit eggs which hatch in due time and the young larvae usually enter the side of the fruit. Two broods appear to be the rule in the northern fruit-growing sections of the United States though some investigators claim a third in the southwest.

Experimental work. The work of the last two years with the codling moth was continued the present season with extremely gratifying results. Comparative tests were made to ascertain the value of but one spraying just after the blossoms fall, with a similar treatment supplemented by a second application about three weeks later, namely, about the time when the young codling moth larvae enter the fruit. The third plot received, in addition to the two sprayings described above, a thorough application the latter part of July, designed especially to control the second brood. One plot, in continuance of the work of last year, was given only one application about three weeks after the blossoms dropped simply to test the relative value of this treatment. Check or unsprayed trees were left for comparison in each of the series.

Location and treatment of plots. Series 1 The experiments in this series were conducted in the young orchard belonging to Mr W. H. Hart of Arlington, N. Y., near Poughkeepsie and located close to Briggs Station on the Hopewell branch of the Central New England Railroad. The orchard is on a moderately high hill, the trees being thrifty, about 17 years old, 18 to 20 feet high and 30 feet apart. The experimental trees were in all cases Baldwins. Each plot consisted of approximately 42 trees, 6 trees in a row one way and 7 in a row the other way, the central 6 being the actual experimental trees. These latter were carefully selected for uniformity in size, fruitage and infestation. The one exception to the arrangement outlined above occurred in plot 4 and the check trees. These latter were the central 2 of the usual 6 experimental trees, while the other 4 in the center of a plot containing 42 trees received only the one late application. All of the barrier trees were sprayed at the usual time. This modification was made because the owner did not wish to have too many trees unprotected or only partially protected from codling moth work. The systematic and thorough commercial spraying of the two preceding years had served to keep this orchard in excellent condition and, as a consequence, there was not an excessive infestation by the

codling moth. The conditions we consider typical of a well-kept commercial orchard. Plots 1, 2 and 3 were located in the northern end of the orchard on a gently sloping side hill, the actual experimental trees being separated from adjacent woodland by at least three barrier trees. The conditions were fairly uniform, the plots producing respectively 16,638, 19,994 and 20,926 apples. It will thus be seen that the largest yield was on plots 2 and 3 and, as a consequence, the test for the single spraying was fully as severe as in the case of the trees receiving two and three applications. Plot 4 and the check trees were located near the southern end of the orchard and bore relatively less fruit.

The trees were sprayed for the first time May 18th. The day opened with rain about 7 o'clock, continuing to nearly 9, and then breaking with showers till about 11 o'clock, sprinkling again at 1.45 and with a few showers till about 4.20 p. m., at which time it poured. Spraying began at about 1.25 p. m. on plot 2 at which time there was a slight breeze. The treatment of the actual experimental trees was completed by 1.35 and then working southward those of plot 1 were finished by 1.46. A sprinkling of rain began at 1.45 and was rather lively at 1.46, stopping at 2 p. m. The leaves at this time were partly flooded with rain but there was no marked dripping. An examination of the experimental trees in plots 2 and 1 showed that in the former, sprayed some ten minutes before the rain began to fall, there was very little or no washing, while in plot 1 those trees which had been completed just a few minutes before the rain came, showed some washing though this was limited largely to the carrying of the poison to the lower edge of the leaf where it settled in large drops. There was very little dripping and probably nothing was washed from the blossom ends of the young fruit. Spraying on the barrier trees was started at 2.10 p.m., at which time the trees were wet but not dripping. The experimental trees on plot 3 were sprayed at 3.15 p.m., the foliage being dry. The work in this entire plot was completed about 3.45, though some of the barrier trees on plot 2 were not finished till nearly 4 p.m., at which time there was a sprinkling of rain, it pouring by 4.20. Only 150 gallons were necessary to cover most of four rows in plots 1 and 2, or 59 trees.

The spray applied consisted of 7½ pounds of Grasselli's arsenate of lead (15 per cent arsenic oxid) and 4½ gallons of

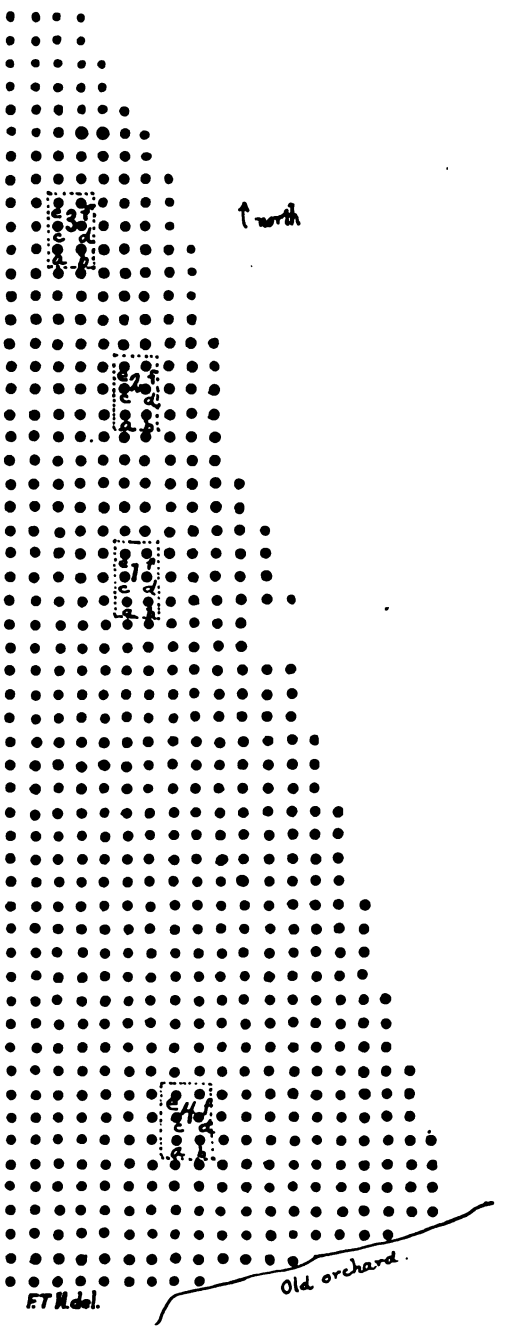

Fig. 1 Plan of Part of the Orchard Belonging to W. H. Hart, Poughkeepsie, Showing the Location of the Plots in Series 1

a concentrated lime-sulfur wash (31° Baumé) to each 150 gallons. The pressure was maintained at from 150 to 160 pounds. The spraying was from the ground, the hose being tied to long bamboo rods and the nozzles were of the later Friend type with apertures which had been worn somewhat by earlier work with a lime-sulfur wash and the spray was therefore rather coarse. Plots 1, 2 and 3 and the barrier trees on plot 4, in which latter were located the check trees, were thoroughly sprayed at this time.

Plots 2 and 3 were sprayed a second time June 8th and the four trees comprising plot 4 for the first and only time on the same day. The weather conditions were perfect, there being a light northwest wind. The material was the same as employed in the earlier application. The entire orchard was then in fine condition. There had been a little burning by the spray on some of the northern spy trees but nothing of the kind was observed on the Baldwins in the experimental plots. Many of the branches showed six or more inches of new growth. Aphids were more or less abundant but not present in sufficiently large numbers to cause serious damage, though a few injured apples were noted in plot 2. Some of the fruit was more or less injured by a green fruit worm or Cacoecia larva. Seven injured apples were picked from tree 2 B and as many from one of the barrier trees in the plot.

The third application to plot 3 was made July 26th, three gallons of spray being used for each tree and an average of a minute being required for the treatment of each tree. An examination at this time showed almost no wormy apples on plot 1, even in the case of trees sprayed just before the rain. Practically the same conditions obtained in plots 2 and 3.

September 28th the spray material was very perceptible and in some instances rather abundant upon the foliage. There was much more russeting or burning of the fruit on plot 3 and the injured areas (plate 6) were checking considerably.

A tabulation of the data is given below.

Series 1, plot 1 (Sprayed once)

TREE	DATE	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT						
			Total	Per cent	Total	Per cent	End wormy	End and side wormy	Side wormy	Exit hole 1	Exit hole 2
A	Aug. 22	130	121	.....	9	.....	.....	.....	9	3	.....
	Sept. 15	21	18	.....	3	.....	.....	.....	3	2	.....
	Sept. 26–28	57	53	.....	4	.....	3	.....	1	.....	.....
		3633	3626	.....	7	.....	2	1	4	.....	.....
		3841	3818	99.40	23	.60	5	1	17	5	.....
B	Aug. 22	31	29	.....	2	.....	.....	.....	2	2	.....
	Sept. 15	14	11	.....	3	.....	.....	.....	3	1	.....
	Sept. 26–28	17	14	.....	3	.....	.....	.....	3	.....	.....
		1732	1724	.....	8	.....	1	.....	7	.....	.....
		1794	1778	99.11	16	.89	1	.....	15	3	.....
C	Aug. 22	119	113	.....	6	.....	.....	.....	6	6	.....
	Sept. 15	48	43	.....	5	.....	2	1	2	4	.....
	Sept. 26–28	45	37	.....	8	.....	2	1	5	1	.....
		3859	3842	.....	17	.....	4	.....	13	6	.....
		4071	4035	99.12	36	.88	8	2	26	17	.....
D	Aug. 22	58	57	.....	1	.....	.....	.....	1	1	.....
	Sept. 15	19	15	.....	4	.....	.....	.....	4	2	.....
	Sept. 26–28	14	13	.....	1	.....	.....	1	.....	.....	.....
		1788	1783	.....	5	.....	1	1	3	1	.....
		1879	1868	99.41	11	.59	1	2	8	4	.....
E	Aug. 22	104	101	.....	3	.....	.....	.....	3	2	.....
	Sept. 15	26	24	.....	2	.....	.....	.....	2	1	.....
	Sept. 26–28	24	24	.....	0	.....	.....	.....	0	0	.....
		2899	2884	.....	15	.....	1	1	13	4	.....
		3053	3033	99.34	20	.66	1	1	18	7	.....
F	Aug. 22	68	68	.....	0	.....	.....	.....	.....	.....	.....
	Sept. 15	11	8	.....	3	.....	.....	.....	3	2	.....
	Sept. 26–28	15	6	.....	9	.....	1	6	2	2	.....
		1906	1901	.....	5	.....	2	.....	3	.....	.....
		2000	1983	99.15	17	.85	3	6	8	4	.....
	Grand total	16638	16515	99.26	123	.74	19	12	92	40	.....

Series 1, plot 2 (Sprayed twice)

EE	DATE	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT						
			Total	Per cent	Total	Per cent	End wormy	End and side wormy	Side wormy	Exit hole 1	Exit hole 2
A	Aug. 22	270	263	.....	7	.....	.....	.....	7	4	.....
	Sept. 15	33	30	.....	3	.....	.....	1	2	3	.....
	Sept. 26–28	64	58	.....	6	.....	1	.....	5	1	.....
		3940	3923	.....	17	.....	2	1	14	.....	.....
		4307	4274	99.23	33	.77	3	2	28	8	.....
B	Aug. 22	202	198	.....	4	.....	.....	.....	4	4	.....
	Sept. 15	25	25	.....	0	.....	.....	0	0	.....	.....
	Sept. 26–28	48	47	.....	1	.....	.....	.....	1	.....	.....
		3355	3351	.....	4	.....	.....	1	3	1	.....
		3630	3621	99.75	9	.25	.....	1	8	5	.....
	Aug. 22	119	118	.....	1	.....	.....	.....	1	1	.....
	Sept. 15	39	36	.....	3	.....	.....	.....	3	1	.....
	Sept. 26–28	60	58	.....	2	.....	.....	.....	2	1	.....
		3136	3136	.....	0	.....	.....	.....	0	0	.....
		3354	3348	99.82	6	.18	.....	.....	6	3	.....
	Aug. 22	237	235	.....	2	.....	1	.....	1	2	.....
	Sept. 15	48	46	.....	2	.....	1	.....	1	1	.....
	Sept. 26–28	83	73	.....	10	.....	.....	.....	10	1	1
		3901	3897	.....	4	.....	.....	.....	4	1	.....
		4269	4251	99.58	18	.42	2	.....	16	5	1
	Aug. 22	128	126	.....	2	.....	.....	.....	2	2	.....
	Sept. 15	18	13	.....	5	.....	.....	.....	5	2	.....
	Sept. 26–28	43	39	.....	4	.....	.....	.....	4	2	.....
		1194	1191	.....	3	.....	.....	.....	3	.....	.....
		1383	1369	98.98	14	1.02	.....	.....	14	6	.....
	Aug. 22	131	127	.....	4	.....	.....	.....	4	4	.....
	Sept. 15	28	27	.....	1	.....	.....	.....	1	0	.....
	Sept. 26–28	45	44	.....	1	.....	.....	.....	1	1	.....
		2847	2842	.....	5	.....	.....	.....	5	1	.....
		3051	3040	99.64	11	.36	.....	.....	11	6	.....
	Grand total	19994	19903	99.54	91	.46	5	3	83	33	1

Series 1, plot 3 (Sprayed thrice)

TREE	DATE	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT						
			Total	Per cent	Total	Per cent	End wormy	End and side wormy	Side wormy	Exit hole 1	Exit hole 2
A	Aug. 22	207	206	.....	1	.....	.....	.....	1	.....	.....
	Sept. 15	26	26	.....	0	.....	.....	.....	0	.....	.....
	Sept. 26–28	108	107	.....	1	.....	.....	.....	1	.....	.....
		3881	3879	.....	2	.....	.....	.....	2	1	.....
		4222	4218	99.90	4	.10	.....	.....	4	1	.....
B	Aug. 22	185	182	.....	3	.....	.....	.....	3	1	.....
	Sept. 15	22	22	.....	0	.....	0	.....	0	.....	.....
	Sept. 26–28	73	69	.....	4	.....	2	.....	2	1	.....
		2193	2187	.....	6	.....	.....	.....	6	4	.....
		2473	2460	99.47	13	.53	2	.....	11	6	.....
C	Aug. 22	195	192	.....	3	.....	.....	.....	3	2	.....
	Sept. 15	14	13	.....	1	.....	.....	.....	1	1	.....
	Sept. 26–28	34	33	.....	1	.....	.....	.....	1	1	.....
		2471	2471	.....	0	.....	.....	.....	0	.....	.....
		2714	2709	99.81	5	.19	.....	.....	5	4	.....
D	Aug. 22	391	374	.....	17	.....	2	.....	15	12	.....
	Sept. 15	52	47	.....	5	.....	1	.....	4	3	.....
	Sept. 26–28	75	71	.....	4	.....	2	.....	2	2	.....
		3829	3821	.....	8	.....	1	2	5	3	.....
		4347	4313	99.22	34	.78	6	2	26	20	.....
E	Aug. 22	89	88	.....	1	.....	0	.....	1	1	.....
	Sept. 15	113	113	.....	0	.....	0	.....	.....	.....	.....
	Sept. 26–28	82	72	.....	10	.....	3	.....	7	3	.....
		2901	2901	.....	0	.....	.....	.....	.....	.....	.....
		3185	3174	99.65	11	.35	3	.....	8	4	.....
F	Aug. 22	121	112	.....	9	.....	0	.....	9	8	.....
	Sept. 15	29	26	.....	3	.....	3	.....	0	0	.....
	Sept. 26–28	153	138	.....	15	.....	3	.....	12	3	.....
		3682	3680	.....	2	.....	.....	.....	2	.....	.....
		3985	3956	99.27	29	.23	6	.....	23	11	.....
	Grand total	20926	20810	99.54	96	.46	17	2	77	46	.....

Series 1, plot 4 (Sprayed once, late)

TREE	DATE	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT						
			Total	Per cent	Total	Per cent	End wormy	End and side wormy	Side wormy	Exit hole 1	Exit hole 2
A	Aug. 22	181	178	.....	3	.....	1	.....	2	1	.....
	Sept. 15	42	22	.....	20	.....	7	3	10	4	.....
	Sept. 26–28	102	63	.....	39	.....	10	2	27	7	.....
		2705	2658	.....	47	.....	8	6	33	6	.....
		3030	2921	96.40	109	3.60	26	11	72	18	.....
B	Aug. 22	73	60	.....	13	.....	4	3	6	7	.....
	Sept. 15	53	10	.....	43	.....	25	5	13	22	.....
	Sept. 26–28	35	9	.....	26	.....	6	7	13	9	.....
		848	767	.....	81	.....	24	21	36	26	.....
		1009	846	83.84	163	16.16	59	36	68	64	.....
C	Aug. 22	185	175	.....	10	.....	2	1	7	6	.....
	Sept. 15	30	15	.....	15	.....	5	3	7	4	.....
	Sept. 26–28	51	36	.....	15	.....	3	3	9	5	.....
		2454	2415	.....	39	.....	15	4	20	7	.....
		2720	2641	97.09	79	2.91	25	11	43	22	.....
D	Aug. 22	171	139	.....	32	.....	15	.....	17	18	.....
	Sept. 15	78	16	.....	62	.....	29	15	18	29	.....
	Sept. 26–28	76	21	.....	55	.....	13	7	35	12	.....
		1885	1809	.....	76	.....	19	15	42	20	.....
		2210	1985	89.82	225	10.18	76	37	112	79	.....
	Grand total	8969	8393	93.57	576	6.43	186	95	295	183	.....

Series 1, check trees (Unsprayed)

TREE	DATE	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT						
			Total	Per cent	Total	Per cent	End wormy	End and side wormy	Side wormy	Exit hole 1	Exit hole 2
X	Aug. 22	199	108	.....	91	.....	51	10	30	34	.....
	Sept. 15	152	27	.....	125	.....	88	17	20	47	.....
	Sept. 26–28	92	34	.....	58	.....	16	12	30	24	2
		2524	2411	.....	113	.....	49	24	40	27	.....
		2967	2580	86.95	387	13.05	204	63	120	132	2
Y	Aug. 22	145	72	.....	73	.....	32	18	23	30	.....
	Sept. 15	131	19	.....	112	.....	67	20	25	46	.....
	Sept. 26–28	113	37	.....	76	.....	18	20	38	31	.....
		1981	1832	.....	149	.....	58	45	46	46	1
		2370	1960	82.70	410	17.30	175	103	132	153	1
	Grand total	5337	4540	85.06	797	14.94	379	166	252	285	3

A study of the above data reveals several very interesting facts. The 16,638 apples of plot 1 are fairly evenly distributed between the 6 trees, the numbers ranging from 1794 to 4071. The average percentage of worm-free fruit is 99.26, the individual trees varying from 99.11 to 99.41. The total wormy fruit is only 123, one tree having but 11, while the maximum is 36. The number of end wormy per tree varies from 1 to 10, while the side wormy range from 10 to 28, a total of 31 end wormy and 104 side wormy. Assuming that the percentage of infested fruit on the check trees in this series is typical for the plot, we find that one application has reduced the infestation by 14 per cent, or resulted in removing from the wormy column some 2329 apples, about 4½ barrels. The cost of spraying the 6 trees was 48 cents, or less than 12 cents for each barrel of fruit kept from being thrown into second-class or cider apples as an outcome of injury by codling moth. The financial returns from this transaction are apparent.

The 19,994 apples of plot 2 range in number per individual tree from 1383 to 4307. The percentage of sound fruit is 99.54, a variation for individual trees of from 98.98 to 99.82. The total wormy is only 91, there being only 8 of these end wormy and 86 side wormy. The end wormy per tree vary from nothing to 5, while the side wormy range from 6 to 30. The second treatment resulted in an additional gain of slightly over ¼ of 1 per cent (.28 per cent) over the single treatment for plot 1. Obviously, the returns from this second spraying are relatively less than in the case of the first.

The total fruit in plot 3 amounts to 20,926, individual trees producing from 2473 to 4347. The percentage of worm-free fruit was exactly the same as in plot 2, 99.54, the variations ranging from 99.22 to 99.90. There were a few more wormy apples than in plot 2, namely, 96, 19 of these being end wormy and 79 side wormy. There appears to have been no material benefit in the case of this plot, resulting from the third spraying. This is more probably chargeable to the extreme thoroughness of the first two applications rather than being attributable to any defect in method. The margin of less than ½ per cent (.46 per cent) is so small that at best only a very slight difference could be expected.

Plot 4 comprises only 4 trees producing 8969 apples, individual trees yielding from 1009 to 3030. The percentage of

worm-free fruit was 93.57, individual trees varying from 83.84 to 97.09. There were 576 wormy apples, 281 being end wormy and 390 side wormy. The great relative increase in end wormy apples is apparent at once and is easily explained by the one application being so late that it was impossible thoroughly to poison the floral organs and the calyx cavity. Even this treatment was worth while if compared with the results on unsprayed trees, since in this plot we have an average of over 93½ per cent of sound fruit as compared with a trifle over 85 per cent on the check trees, a gain of 8½ per cent or of over 760 sound apples, approximately a barrel and a half at a cost for spraying of about 32 cents. The treatment paid for itself, though the profit was not nearly so great as in the case of the first application.

The two check trees produced 5337 apples, one yielding 2370, the other 2967. The average percentage of sound fruit was 85.06, while the number of wormy apples was 797, 545 of these being end wormy and 418 side wormy. A comparison of these figures with those of plots 1, 2 and 3 show at once that the major portion of the benefit from the early applications at least is in the destruction of the codling moth caterpillars as they attempt to enter the calyx end of the young fruit. These data simply confirm the importance of making the first spraying at the proper time and doing it most thoroughly, since it is the early application which gives the most benefit.

Series 2. The experiments in this series were conducted in the orchard of Mr Edward VanAlstyne at Kinderhook, N. Y. Plot 1, comprising greenings, was located on the southwestern side of the road next the shed. Plot 2 was some rows farther north and west on the same side of the road, plot 3 several rows still farther north on the east side of the road, and plot 4, comprising only two trees, on the west side of the road and near two check trees. The relative location of the trees in plot 4 and the checks was nearly the same as in Mr Hart's orchard, though owing to the uneven setting of fruit a symmetrical distribution was impossible. All of the trees except in plot 1 were Baldwins. The conditions in plots 1 to 3 were fairly uniform, these plots producing respectively, 20,802, 34,019, and 31,119 apples. The largest yields were therefore limited to the plots receiving the most sprayings and, as a consequence, the test for the single application was rather more severe.

The treatment was substantially the same as in series 1, except that lead arsenate (15½ per cent arsenic oxid), manufactured by the Interstate Chemical Co., was used at the rate of 15 pounds to 250 gallons of water, and a concentrated home-made lime-sulfur wash, 40-80 formula (27° Baumé) was used at the rate of 1 gallon to 25 of the spray. The spraying began May 23d. The trees were 18 to 25 feet high and the work slower and if anything more careful than in series 1. The tower was used, one man being located on this and the other with an extension nozzle operating from the ground. There was probably considerably more liquid applied per tree than in the preceding series. The blossom ends were well sprinkled but there was practically no penetration of the poison to the inner calyx cavity. The leaves were well covered with the poison and rarely flooded. There were still a few blossoms on the ends of the limbs. The eastern barrier rows of plot 1 were completely sprayed on the first day, and the three rows next the driveway and west were sprayed from the east side beginning with the experimental trees in plot 1. The next day, the 24th, a few of the remaining trees were sprayed with the wind in the opposite direction, though nearly constant showers seriously hindered operations. The remainder of the plots, including the barrier trees, were finished May 25th. Trees A and B on plot 2 were sprayed on the morning of the 24th, the application being followed shortly by heavy showers. The spray, however, could be seen upon the foliage the following day. The weather during both the 24th and 25th was rather showery and spraying was frequently interrupted.

Plots 2, 3 and 4 were sprayed June 19th. The weather was bright and clear with a light southeast wind. The work began at 9.30 a.m. and was completed at 3.15 p.m. The B tree in plot 2 contained a nest of fall webworms; this was also true of one of the barrier trees. There was throughout the orchard considerable crinkling and yellowing of leaves, which might be attributed to former applications were it not that the unsprayed trees on plot 4 as well as the check trees exhibited the same conditions. There had been an excellent growth and the foliage had a good color. The fruit presented a fine appearance and there was an excellent setting with but few exceptions.

Plot 3 was sprayed for the third and last time July 29th, using only arsenate of lead in the proportions previously employed.

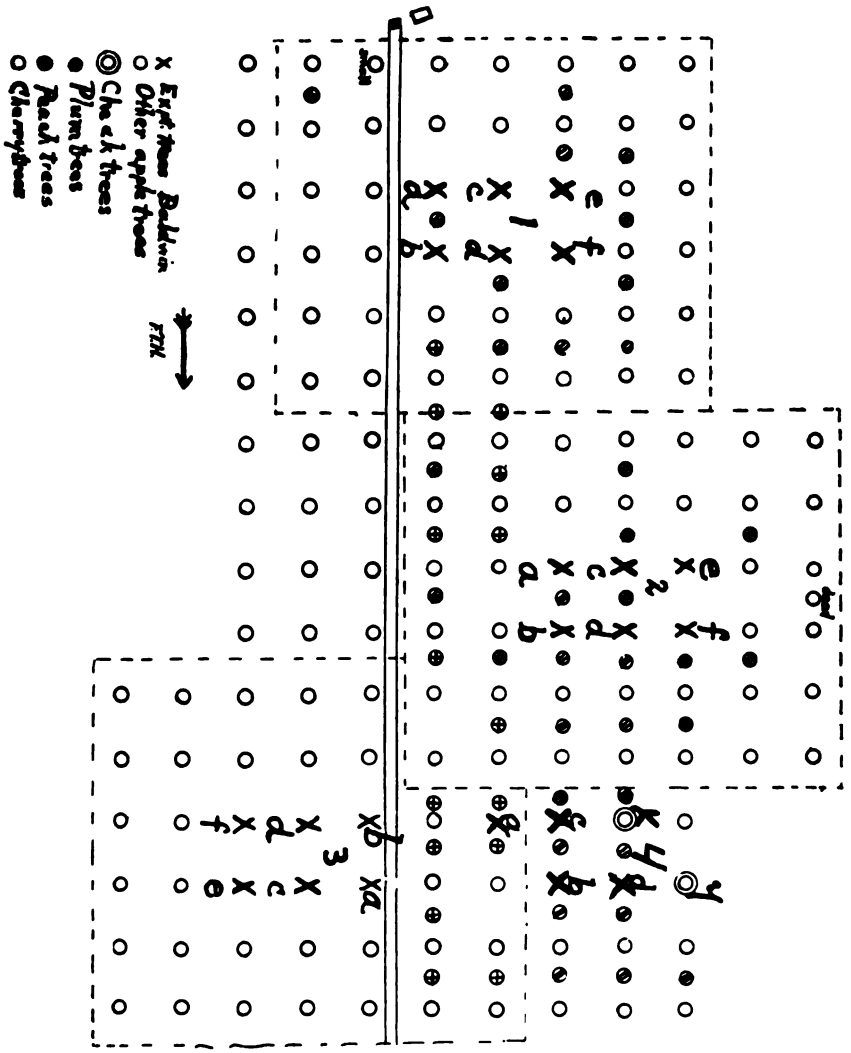

Fig. 2 Plan of Orchard Belonging to Edward Van Alstyne, Kinderhook, Showing the Location of the Plats in Series 2

The application was thorough and was confined to the six experimental trees. There was a slight breeze though not sufficient to interfere with operations. The trees on plot 1 were well laden, healthy, and the fruit was developing very nicely. Very few or no wormy apples were seen and there were very few on the ground. A rather large number of small apples were on the ground in plot 2, the drop probably being the result of drought. There were a number with brown, scabby areas on the side exposed to the sun, probably due to sun scald. There were very few or no wormy apples. There was abundant fruit on plot 3 except on small portions of one or two trees. There was rather more injury to the fruit possibly than on plot 2 and certainly more than on plot 4. The spray was evident on the foliage and very few or no wormy apples were to be seen. Some wormy fruit was seen on plot 4 but not so much as on the checks. Some of the apples were injured by sun scald though not so much as on plot 2. Some were badly checked later (plate 7). There were only two trees on plot 4 with a good setting of fruit. The checks bore markedly more wormy apples than the other trees and had practically no fruit injured by sun scald.

A tabulation of the data follows:

Series 2, plot 1 (Sprayed once)

TREE	DATE	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT						
			Total	Per cent	Total	Per cent	End wormy	End and side wormy	Side wormy	Exit hole 1	Exit hole 2
A	Aug. 24.....	244	238	.....	6	.....	.....	.....	6	2	.....
	Sept. 19.....	629	622	.....	7	.....	1	.....	6	.....	.....
	Oct. 2.....	184	166	.....	18	.....	1	1	16	2	.....
		2895	2868	.....	27	.....	1	.....	26	.....	.....
		3952	3894	98.53	58	1.47	3	1	54	4	.....
B	Aug. 24.....	213	196	.....	17	.....	2	.....	15	14	.....
	Sept. 19.....	359	347	.....	12	.....	1	.....	11	.....	.....
	Oct. 2.....	234	189	.....	45	.....	3	1	41	3	.....
		2129	2090	.....	39	.....	2	2	35	5	.....
		2935	2822	96.15	113	3.83	8	3	102	22	.....
C	Aug. 24.....	281	278	.....	3	.....	.....	.....	3	2	.....
	Sept. 19.....	380	374	.....	6	.....	1	.....	5	3	.....
	Oct. 2.....	256	244	.....	12	.....	.....	.....	12	1	.....
		3345	3333	.....	12	.....	1	.....	11	.....	.....
		4262	4229	99.22	33	.78	2	.....	31	6	.....
D	Aug. 24.....	249	247	.....	2	.....	1	.....	1	1	.....
	Sept. 19.....	660	648	.....	12	.....	2	.....	10	6	.....
	Oct. 2.....	134	124	.....	10	.....	.....	1	9	2	.....
		2215	2198	.....	17	.....	.....	1	16	6	.....
		3258	3217	98.74	41	1.26	3	2	36	15	.....
E	Aug. 24.....	233	226	.....	7	.....	1	.....	6	5	.....
	Sept. 19.....	483	466	.....	17	.....	1	1	15	9	.....
	Oct. 2.....	193	186	.....	7	.....	1	.....	6	.....	.....
		2269	2253	.....	16	.....	2	1	13	2	.....
		3178	3131	98.52	47	1.48	5	2	40	16	.....
F	Aug. 24.....	163	153	.....	10	.....	1	.....	9	5	.....
	Sept. 19.....	375	347	.....	28	.....	2	5	21	9	2
	Oct. 2.....	222	194	.....	28	.....	3	1	24	6	.....
		2457	2414	.....	43	.....	1	.....	42	.....	.....
		3217	3108	96.61	109	3.39	7	6	96	20	2
	Grand total..	20802	20401	98.07	401	1.93	28	14	359	83	2

Series 2, plot 2 (Sprayed twice)

TREE	DATE	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT						
			Total	Per cent	Total	Per cent	End wormy	End and side wormy	Side wormy	Exit hole 1	Exit hole 2
A	Aug. 24	403	395	.....	8	.....	.....	.....	8	8	.....
	Sept. 19	270	257	.....	13	.....	2	.....	11	6	.....
	Oct. 5	567	562	.....	5	.....	.....	.....	5	1	.....
		4024	4020	.....	4	.....	.....	.....	4	.....	.....
		5264	5234	99.43	30	.57	2	.....	28	15	.....
B	Aug. 24	429	420	.....	9	.....	.....	.....	9	5	.....
	Sept. 19	449	416	.....	33	.....	6	4	23	18	3
	Oct. 5	653	607	.....	46	.....	4	10	32	18	1
		5755	5724	.....	31	.....	1	3	27	11	.....
		7286	7167	98.37	119	1.63	11	17	91	52	4
C	Aug. 24	513	506	.....	7	.....	1	.....	6	4	.....
	Sept. 19	800	775	.....	25	.....	1	3	21	7	2
	Oct. 5	950	928	.....	22	.....	3	1	18	.....	.....
		3522	3507	.....	15	.....	3	2	10	5	.....
		5785	5716	98.81	69	1.19	8	6	55	16	2
D	Aug. 24	309	300	.....	9	.....	2	.....	7	6	.....
	Sept. 19	319	291	.....	28	.....	3	7	18	14	3
	Oct. 5	425	381	.....	44	.....	5	9	30	11	.....
		3102	3081	.....	21	.....	2	2	17	10	.....
		4155	4053	97.54	102	2.46	12	18	72	41	3
E	Aug. 24	253	242	.....	11	.....	1	.....	10	6	.....
	Sept. 19	151	130	.....	21	.....	2	2	17	14	.....
	Oct. 5	486	452	.....	34	.....	1	4	29	17	.....
		4480	4466	.....	14	.....	2	.....	12	.....	.....
		5370	5290	98.51	80	1.49	6	6	68	37	.....
F	Aug. 24	451	443	.....	8	.....	1	.....	7	5	.....
	Sept. 19	412	372	.....	40	.....	5	.....	35	21	1
	Oct. 5	635	596	.....	39	.....	8	7	24	15	.....
		4661	4639	.....	22	.....	.....	.....	22	1	.....
		6159	6050	98.23	109	1.77	14	7	88	42	1
	Grand total	34019	33510	98.50	509	1.5	53	54	402	203	10

Series 2, plot 3 (Sprayed thrice)

TREE	DATE	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT						
			Total	Per cent	Total	Per cent	End wormy	End and side wormy	Side wormy	Exit hole 1	Exit hole 2
A	Sept. 1	308	264	.....	44	.....	8	1	35	19	.....
	Sept. 21	380	358	.....	22	.....	7	.....	15	7	.....
	Oct. 9	628	614	.....	14	.....	3	2	9	3	.....
		2074	2059	.....	15	.....	2	3	10	5	.....
		3390	3295	97.20	95	2.80	20	6	69	34	.....
B	Sept. 1	925	898	.....	27	.....	2	3	22	16	.....
	Sept. 21	1154	1145	.....	9	.....	3	3	3	3	.....
	Oct. 2 and 9	1332	1327	.....	5	.....	2	.....	3	.....	.....
		3571	3568	.....	3	.....	1	1	1	1	.....
		6982	6938	99.37	44	.63	8	7	29	20	.....
C	Sept. 1	434	421	.....	13	.....	2	.....	11	7	.....
	Sept. 21	452	440	.....	12	.....	5	.....	7	7	.....
	Oct. 9	1001	992	.....	9	.....	.....	3	6	4	.....
		3560	3558	.....	2	.....	1	.....	1	.....	.....
		5447	5411	99.34	36	.66	8	3	25	18	.....
D	Sept 1	375	358	.....	17	.....	3	3	11	16	.....
	Sept. 21	594	587	.....	7	.....	4	.....	3	2	.....
	Oct. 9	1139	1129	.....	10	.....	.....	2	8	1	.....
		2939	2937	.....	2	.....	.....	.....	2	1	.....
		5047	5011	99.28	36	.72	7	5	24	20	.....
E	Sept. 1	246	236	.....	10	.....	1	.....	9	9	.....
	Sept. 21	270	254	.....	16	.....	8	2	6	9	.....
	Oct. 9	977	969	.....	8	.....	1	.....	7	1	.....
		3251	3244	.....	7	.....	2	.....	5	2	.....
		4744	4703	99.14	41	.83	12	2	27	21	.....
F	Sept. 1	694	682	.....	12	.....	4	.....	8	9	.....
	Sept. 21	1333	1331	.....	2	.....	1	.....	1	.....	.....
	Oct 9	1423	1423	.....	.....	.....	.....	.....	.....	.....	.....
		2059	2058	.....	1	.....	.....	.....	1	.....	.....
		5509	5494	99.73	15	.27	5	.....	10	9	.....
	Grand total	31119	30852	99.14	267	.86	60	23	184	122	.....

Series 2, plot 4 (Sprayed once, late)

TREE	DATE	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT						
			Total	Per cent	Total	Per cent	End wormy	End and side wormy	Side wormy	Exit hole 1	Exit hole 2
A	Aug. 25	757	433	.....	324	.....	171	32	121	219	.....
	Sept. 20	1440	951	.....	489	.....	245	96	148	339	14
	Oct. 6	1016	647	.....	369	.....	86	92	191	107	6
		3975	3673	.....	302	.....	64	68	170	70	.....
		7188	5704	79.35	1484	20.65	566	288	630	735	20
B	Aug. 25	727	415	.....	312	.....	116	10	186	256	.....
	Sept. 20	1445	833	.....	612	.....	279	94	239	311	9
	Oct. 6	737	477	.....	260	.....	67	26	165	74	1
		3887	3667	.....	220	.....	67	24	129	39	1
		6796	5392	79.34	1404	20.66	529	156	719	680	11
C	Aug. 25	68	44	.....	24	.....	9	4	11	16	.....
	Sept. 20	156	131	.....	25	.....	11	2	12	12	.....
	Oct. 6	52	37	.....	15	.....	4	3	8	6	.....
		341	299	.....	42	.....	15	7	20	16	.....
		617	511	82.80	106	17.20	39	16	51	50	.....
D	Aug. 25	286	78	.....	208	.....	115	12	81	103	.....
	Sept. 20	388	132	.....	256	.....	120	46	90	130	2
	Oct. 6	322	197	.....	125	.....	18	29	78	47	2
		1218	1099	.....	119	.....	35	31	53	37	.....
		2214	1506	68.02	708	31.98	288	118	302	317	4
	Grand total	16815	13113	77.98	3702	22.02	1422	578	1702	1782	35

Series 2, check trees (Unsprayed)

TREE	DATE	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT						
			Total	Per cent	Total	Per cent	End wormy	End and side wormy	Side wormy	Exit hole 1	Exit hole 2
X	Sept. 1	1411	669	.....	742	.....	447	41	254	427	11
	Sept. 22	2885	1563	.....	1322	.....	585	249	488	770	21
	Oct. 2–6	943	507	.....	436	.....	131	113	192	126	5
		4279	3679	.....	600	.....	168	137	295	153	5
		9518	6418	67.43	3100	32.57	1331	540	1229	1476	42
Y	Aug. 24	356	103	.....	253	.....	116	25	112	160	4
	Sept. 20	1249	453	.....	796	.....	431	149	216	364	5
	Oct. 6	701	435	.....	266	.....	65	90	111	76	1
		2846	2451	.....	395	.....	105	145	145	103	2
		5152	3442	66.81	1710	33.19	717	409	584	703	12
	Grand total	14670	9860	67.21	4810	32.79	2048	949	1813	2179	54

Series 2 largely confirms the results obtained in series 1 though the crop was somewhat larger, the trees older and consequently more difficult to spray thoroughly. On the other hand the nearly level ground facilitated the use of a tower, while the greater abundance of the codling moth afforded a more severe test of the efficacy of spraying.

Plot 1 produced 20,802 apples, the individual trees yielding from 2935 to 4262. The average percentage of sound fruit was 98.07, the trees varying from 96.15 to 99.22. There were 401 wormy apples, the number per tree ranging from 33 to 109. There were only 42 end wormy, while the great majority, 373, were side wormy. This one treatment resulted in saving nearly 21 per cent of what otherwise would have been wormy fruit or about 4000 apples, approximately 8 barrels. This was effected at a cost of about 60 cents or less than 10 cents per barrel.

Plot 2 produced a total of 34,019 apples, the individual trees yielding from 4155 to 7286. The average percentage of worm-free fruit was 98.50, the trees varying from 98.23 to 99.43. There were 509 wormy apples, 107 being end wormy and 456 side wormy. It will be noted that this second treatment resulted in securing nearly ½ of 1 per cent (.43 per cent) more sound apples than in the case of plot 1.

Plot 3 produced 31,119 apples, the individual trees yielding from 3390 to 6982. The average percentage of sound fruit was 99.14, varying from 97.20 to 99.73. There were only 267 wormy apples, 83 being end wormy and 107 side wormy. Tree A for some reason or other gave distinctly less satisfactory results than the others. It produced over one-third of the wormy apples and had a percentage of only 97.20, otherwise the average percentage would have been perceptibly higher for this plot. As it is, there were about 1 per cent more worm-free apples on plot 3 than on plot 1, and it is possible that there should have been 1½ per cent additional sound fruit.

The four trees of plot 4 produced 16,815 apples, the individual trees varying from 617 to 7188. The percentage of sound fruit was 77.98, it varying from 68.02 to 82.80. There were 3702 wormy apples, 2000 of these being end wormy and 2280 side wormy. Over one-quarter of this latter number included in the totals of end wormy and of side wormy were end and side wormy. Accepting the check trees as standard, this one late application resulted in nearly 10 per cent additional sound fruit or about *1600 apples, over three* barrels, the one treatment cost-

ing approximately 40 cents. It paid for itself though the work would have been much more profitable had it been done three weeks earlier.

The check trees yielded 14,670 apples, the individual trees 5152 and 9518. The average percentage of sound fruit was 67.21, there being very little variation in this respect. These two trees produced 4810 wormy apples, 2997 being end wormy and 2762 side wormy. Here we have again most conclusive evidence showing that the major portion of the protection accrues from the first spraying as a result of its destroying young codling moth caterpillars entering at the blossom end of the fruit.

Series 3. Certain corroborative experiments were conducted in the young orchard of Mr William Hotaling of Kinderhook, N. Y. The trees are exceptionally fine, being only six or seven years old, dwarf in habit and, as a rule, well laden for such young trees. They are set in four rows, running approximately north, with rows of peach trees between, and in the case of the experimental areas the Wealthy apples alternate with Mackintosh. Three plots were laid out, the trees invariably being on the two middle rows. Plot 1 was limited to transverse rows 35, 36, 37 and 38, and plot 2 to transverse rows 39, 40, 41, 42, 43, 44 and 45, numbering from the house toward the railroad. The check trees were in transverse rows 23, 24 and 25. The trees were small and the spraying was very thorough, being made by Mr Hotaling personally. He took special pains to cover the under as well as the upper surface of the leaves, applying so much that there was considerable dripping. There was relatively more spray material used for each tree than in any other experiments during the season. Arsenate of lead (15 per cent arsenic oxid) was used at the rate of 4 pounds to 44 gallons of mixture, and a home-made lime-sulfur wash (33° Baumé) at a rate of 1 gallon to 30 gallons of spray. The first treatment was given May 23d to plots 1 and 2. Plot 2 was sprayed a second time June 19th, the treatment being limited to the experimental trees and the barrier trees in the longitudinal rows. At that time much of the fruit in this orchard had dropped, though it was not attributed to the spraying. There was some burning from the earlier application to the

barrier trees though there seemed to be no injury to the experimental trees. The orchard presented a fine appearance, many twigs showing a growth of 8 or 10 inches. There was remarkable freedom from insect injury though near the house one tree had practically every apple injured by the codling moth.

The results secured in this series are tabulated below.

Series 3, Mackintosh, plot 1 (Sprayed once)

TREES	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT						
		Total	Per cent	Total	Per cent	End wormy	End and side wormy	Side wormy	Exit hole 1	Exit hole 2
A	39	36	92.30	3	7.70	1	.....	2	.....	.....
B	3	2	66.66	1	33.34	.....	.....	1	.....	.....
E	119	109	91.60	10	8.40	2	.....	8	2	.....
F	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
I	34	29	85.30	5	14.70	1	1	3	.....	.....
J	77	64	83.11	13	16.89	3	2	8	4	.....
Total	272	240	88.23	32	11.77	7	3	22	6	.....

Series 3, Mackintosh, plot 2 (Sprayed twice)

TREES	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT						
		Total	Per cent	Total	Per cent	End wormy	End and side wormy	Side wormy	Exit hole 1	Exit hole 2
A	37	35	94.60	2	5.40	1	.....	1	1	.....
B	39	37	94.87	2	5.13	.....	.....	2	2	.....
E	10	10	100	.....	.....	.....	.....	.....	.....	.....
F	16	16	100	.....	.....	.....	.....	.....	.....	.....
I	251	239	95.20	12	4.80	1	.....	11	1	.....
J	212	205	96.70	7	3.30	2	.....	5	2	.....
M	57	56	98.25	1	1.75	.....	1	.....	.....	.....
N	16	13	81.25	3	18.75	1	.....	2	.....	.....
Total	638	611	95.76	27	4.24	5	1	21	6	.....

Series 3, Wealthy, plot 1 (Sprayed once)

TREES	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT						
		Total	Per cent	Total	Per cent	End wormy	End and side wormy	Side wormy	Exit hole 1	Exit hole 2
C	604	592	98	12	2	1	.....	11	.....	.....
D	273	262	96	11	4	1	.....	10	1	.....
G	69	65	94.20	4	6.80	.....	.....	4	.....	.....
H	225	213	94.66	12	5.34	1	.....	11	2	.....
K	202	192	95.05	10	4.95	.....	.....	10	2	.....
L	57	50	87.72	7	12.28	1	.....	6	.....	.....
Total	1430	1374	96.08	56	3.92	4	.....	52	5	.....

Series 3, Wealthy, plot 2 (Sprayed twice)

TREES	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT						
		Total	Per cent	Total	Per cent	End wormy	End and side wormy	Side wormy	Exit hole 1	Exit hole 2
C	398	395	99.24	3	.76	.....	.....	3	.....	.....
D	179	175	97.76	4	2.24	.....	.....	4	.....	.....
G	407	403	99.01	4	.99	1	.....	3	.....	.....
H	14	14	100	0	0	.....	.....	.....	.....	.....
K	83	82	98.79	1	1.21	.....	.....	1	.....	.....
L	87	87	100	0	.....	.....	.....	.....	.....	.....
Total	1168	1156	98.97	12	1.03	1	.....	11	.....	.....

Series 3, Wealthy, checks (Unsprayed)

TREES	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT						
		Total	Per cent	Total	Per cent	End wormy	End and side wormy	Side wormy	Exit hole 1	Exit hole 2
C	38	17	44.73	21	55.27	13	3	5	3	.....
D	2	.....	.....	2	100	.....	.....	2	.....	.....

Series 3, Mackintosh, checks (Unsprayed)

TREE	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT						
		Total	Per cent	Total	Per cent	End wormy	End and side wormy	Side wormy	Exit hole 1	Exit hole 2
E.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
F.....	29	17	58.62	12	.....	3	6	3	1	.....

Series 3, Winesap, checks (Unsprayed)

TREE	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT						
		Total	Per cent	Total	Per cent	End wormy	End and side wormy	Side wormy	Exit hole 1	Exit hole 2
A.....	20	10	50	10	50	4	4	2	2	.....
B.....	29	14	48.27	15	51.73	15	.....	.....	.....	.....
Total.....	118	58	49.15	60	50.85	35	13	12	6	.....

Series 3 is interesting largely because it shows the results which may be expected on small trees producing comparatively few apples. It also illustrates a marked difference in the liability of different varieties to injury by this pest.

The six Mackintosh trees in plot 1 produced a total of only 272 apples, the average percentage of sound fruit being 88.23, individual fruiting trees ranging from 66.66 to 92.30, though the maximum and minimum number of wormy apples were only 1 and 13.

Plot 2. The six Mackintosh trees produced 638 apples, giving an average percentage of 95.76 of sound fruit. There were only 27 wormy apples in the plot, the number per tree ranging from nothing to 12, yet the percentage variations ran from 81.25 to 100.

The six Wealthy trees in plot 1 produced 1430 apples, giving an average of 96.08 per cent of sound fruit. There were 56 wormy apples, individual trees producing from 4 to 12 and giving a percentage variation from 87.72 to 98.

The six Wealthy trees in plot 2 produced 1168 apples, an average of 98.97 per cent of sound fruit. Individual trees bore from none to 4 wormy apples, yet the percentage variation ranged from 98.79 to 100.

The above data should be compared with the 58.62 per cent of sound fruit produced by one check Mackintosh tree, and the 44.73 per cent of worm-free fruit on a check Wealthy tree. The comparisons show a decided advantage accruing from spraying though there is a wide variation in the percentage of sound fruit.

A summarized tabulation of the results secured from all the plots emphasizes certain important points and is therefore given below.

Summary of plots

SERIES	PLOT	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT						
			Total	Per cent	Total	Per cent	End wormy	End and side wormy	Side wormy	Exit hole 1	Exit hole 2
1	1.....	16638	16515	99.26	123	.74	19	12	92	40	.....
	2.....	19994	19903	99.54	91	.46	5	3	83	33	1
	3.....	20926	20830	99.54	96	.46	17	2	77	46	.....
	4.....	8969	8393	93.57	576	6.43	186	95	295	193	.....
	Check....	5337	4540	85.06	797	14.94	379	166	252	285	3
2	1.....	20802	20401	98.07	401	1.93	28	14	359	83	2
	2.....	34019	33510	98.50	509	1.5	53	54	402	203	10
	3.....	31119	30852	99.14	267	.86	60	23	184	122	.....
	4.....	16815	13113	77.98	3702	22.02	1422	578	1702	1782	35
	Check....	14670	9860	67.21	4810	32.79	2048	949	1813	2179	54
	Mackintosh:										
3	1.....	272	240	88.23	32	11.77	7	3	22	6	.....
	2.....	638	611	95.76	27	4.24	5	1	21	6	.....
	Check....	29	17	58.62	12	.....	3	6	3	1	.....
	Wealthy:										
	1.....	1430	1374	96.08	56	3.92	4	.....	52	5	.....
	2.....	1168	1156	98.97	12	1.03	1	.....	11	.....	.....
	Check....	38	17	44.73	21	55.27	13	3	5	3	.....

Summary of plots. A study of the entire data shows that conditions were fairly comparable in series 1 and 2, though the yield from the latter was somewhat greater. This larger yield in series 2 is in some measure offset by the trees being larger and more difficult to spray, not only on account of their size but also because of interplanted plum and peach trees. The percentages of sound fruit from the plots in these two series show a fairly uniform increase with additional sprayings, though in the case of

series 1 there is no difference between the percentage of sound fruit produced by plots 2 and 3, each giving an average of 99.54. In series 2, however, there is a nearly uniform gain of ½ of 1 per cent from each spraying after the first. There is a marked contrast between the amount of sound fruit produced on the plots receiving one treatment just after the blossoms dropped and on similar plots sprayed once three weeks later, the benefit resulting from this treatment ranging from one-third to two-thirds that of the early spray. An examination of the data relating to end wormy apples shows a very interesting condition. In series 1, plot 1 there were 31; plot 2, 8; plot 3, 19; plot 4, 281 and in the check trees, 545. It will be observed that the decrease in wormy apples resulting from the various sprayings is very largely in the end wormy, while the poor results following the one late spray must be attributed in considerable measure to failure in destroying the young caterpillars entering the blossom end of the apple. The data relating to the check trees give an idea of the number normally attacking the apple at this point. The same thing is even better illustrated in the figures for series 2. Plot 1 has 42 end wormy; plot 2, 107; plot 3, 83; plot 4, 2000, while the check trees produced 2997 end wormy apples.

A careful comparison of these figures supports the well-established belief that the first spraying within a week or ten days after the blossoms fall is by all odds the most important so far as preventing wormy apples or controlling the codling moth is concerned. Under the conditions obtaining in series 1 and 2, the benefits resulting from the second and third application are comparatively slight and of themselves would hardly justify additional treatment. Should it be advisable to spray for fungous diseases of one kind or another, we would not hesitate to recommend the addition of poison, since even the small benefit recorded above would more than repay the cost of the poison, not to mention the protective or insurance value of these later treatments in case there was an exceptionally large second brood as in 1910.

Summary of three years' work. Conclusions based upon the results of one season are of comparatively slight value. We have therefore brought together in one table the data relating to the experiments of three seasons, 1909–11.

Summary of three years' work with the codling moth

TREATMENT	PLOT	SERIES	YEAR	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT					
					Total	Per cent	Total	Per cent	End wormy	End and side wormy	Side wormy	Per cent end worm
Sprayed once	1	1	1909	30177	29818	98.81	359	1.19	33	18	308	
	1	2	1909	21264	21042	98.96	222	1.04	23	18	181	
	1	1	1910	1839	1664	90.48	175	9.52	16	21	138	
	1	2	1910	8135	6677	82.08	1458	17.92	160	27	1271	
	1	1	1911	16638	16515	99.26	123	.74	19	12	92	
	1	2	1911	20802	20401	98.07	401	1.93	28	14	359	
	Grand total and per cent			98855	96117	97.23	2738	2.77	279	110	2349	.394
Sprayed twice	2	1	1909	10316	10206	98.93	110	1.07	4	7	99	
	5	1	1909	19275	19084	99.01	191	.99	10	9	172	
	2	1	1910	2846	2756	96.84	90	3.16	6	1	83	
	2	2	1910	7316	6105	83.45	1211	16.55	127	10	1074	
	2	1	1911	19994	19903	99.54	91	.46	5	3	83	
	2	2	1911	34019	33510	98.50	509	1.5	53	54	402	
	Grand total and per cent			93766	91564	97.65	2202	2.35	205	84	1913	.308
Sprayed thrice	3	1	1909	9680	9582	98.99	98	1.01	8	10	80	
	6	1	1909	7710	7633	99	77	1	6	3	68	
	3	1	1911	20926	20830	99.54	96	.46	17	2	77	
	3	2	1911	31119	30852	99.14	267	.86	60	23	184	
	Grand total and per cent			69435	68897	99.22	538	.78	91	38	409	.185
Sprayed once, late	3	2	1910	7594	4355	57.35	3239	42.65	1485	326	1428	
	4	1	1911	8969	8393	93.57	576	6.43	186	95	295	
	4	2	1911	16815	13113	77.98	3702	22.02	1422	578	1702	
	Grand total and per cent			33378	25861	77.47	7517	22.53	3093	959	3'25	12.26
Unsprayed	Check.	1	1909	3251	2366	72.73	885	27.27	312	302	271	
	"	2	1909	7015	5127	73.08	1888	26.92	674	630	584	
	"	1	1910	711	202	28.41	509	71.59	186	240	82	
	"	2	1910	2000	593	29.65	1407	70.35	700	324	383	
	"	1	1911	5337	4540	85.06	797	14.94	379	166	252	
	"	2	1911	14670	9860	67.21	4810	32.79	2048	949	1813	
	Grand total and per cent			32984	22688	68.78	10296	31.22	4299	2611	3385	20.95

The above data[1] summarize the work for the past three years,

[1] To give a fairer comparison between the results obtained in different years, the figures for plot 4, series 1, and plots 4 and 7, series 2, 1909 were omitted in the above tabulation, thus avoiding the undue preponderance, so far as feasible, of the results of any one season.

the figures being grouped so as to show the results from various applications. The single spray applied to the different plots during this period gave from 82.08 to 99.26 per cent of sound fruit or an average of 97.23 per cent for the three years, when comparisons are made between an equal number of plots in each year. It should be noted that the low percentages occurred in 1910, a season remarkable for the unusual destructiveness of the second brood and one presenting infrequent conditions which were accentuated by the small yield of the experimental trees. Excluding the data for this year, the lowest percentage of sound fruit obtained from one spraying was 97.52. Incidentally we would call attention to the fact that less than ½ of 1 per cent (.394 per cent) of the wormy fruit from the trees receiving but one spray were end wormy.

The six plots receiving two sprayings during this period produced from 83.45 to 99.54 per cent of sound fruit or an average of 97.65 per cent, the end wormy fruit constituting about ⅓ of 1 per cent (.308 per cent). It will be observed that the average gain in sound fruit resulting from this second application was .42 per cent and that there was a slight reduction in the percentage of end wormy.

It was unfortunate that in 1910 no plot received three applications and, as a consequence, the average percentage for this group is 99.22 of sound fruit, a yield undoubtedly relatively higher than would have been the case if two plots for 1910 could have been included. Even with this omission which, in a measure at least, is favorable to the three applications, the average percentage gain between two and three treatments is only 1.57 per cent, while the average percentage of end wormy is even smaller than in the preceding plots, namely, .185 per cent.

The three plots receiving one late application during 1910 and 1911 gave an average percentage of sound fruit of only 77.47, there being a range for individual plots from 57.35 to 93.57. This average percentage of sound fruit is approximately midway between that obtained from one spraying and the yield on the check trees. The percentage of end wormy, 12.26, is a great increase over that in the preceding plots and shows in a convincing manner where the late spray lacks efficiency.

The check trees during this period gave an average percentage of sound fruit of 68.78, the yield varying in individual plots from 28.41 to 85.06. This small yield of good fruit, it should be

noted, occurred on trees producing relatively few apples. The average percentage of end wormy fruit for these plots is 20.95, a great increase in the average for the plots receiving one late spraying and very different from the data for the sprayed plots where the greater number of wormy apples have been injured by the second brood and are therefore side wormy.

A study of the wormy fruit on the check trees during the three-year period shows that nearly one-third (31.22 per cent) of the entire yield was affected and that over two-thirds (20.95 per cent) of this was end wormy. A comparison of the end wormy fruit produced on the sprayed trees shows at once that by far the greatest benefit accrues from the first spraying, since this reduced the percentage of end wormy to .394, a second bringing it down to .308, and a third to .185 per cent. The one late spray (three weeks after blossoming) reduced the end wormy, taking the check trees as a standard, by less than one-half, that is, to 12.26 per cent. The great value of the first application made within a week or ten days after the blossoms fall and preferably early in this period, is at once evident from these data.

Comparative yields. The following tabulation of comparative yields from the experimental plots will prove instructive, since those from the plots sprayed three times, sprayed late and checks have been raised pro rata to make up for a deficiency in the number of plots or a reduced number of trees in the plots and the figures thus indicate a fair comparative value. Those for the plots sprayed three times are undoubtedly somewhat higher than they should be, because there were no plots sprayed thrice in 1910, a year when the second brood of the codling moth was extremely abundant, and as a consequence there was excessive injury.

Comparative summary of yields from experimental plots 1909-11

NUMBER OF SPRAYS	TOTAL FRUIT	CLEAN FRUIT		WORMY FRUIT			
		Number	Per cent	Total	Total end wormy	Total side wormy	Total end and side wormy
1	98 855	96 117	97.23	2 738	389	2 459	110
2	93 766	91 564	97.65	2 202	289	1 997	84
3	104 151	91 863	99.22	807	272	596	50
1 late	66 756	51 722	77.47	15 034	8 184	8 848	1 998
Checks	98 952	68 064	68.78	30 888	20 730	17 988	7 833

It will be noted on referring to the above table, that the reduction in wormy apples is constant, whether we take the total, the total end wormy, the total side wormy or the total end and side wormy, with the increase in the number of sprayings, while the plots sprayed but once and late show a large increase in the wormy apples and the unsprayed or check plots approximately twice as many. The evidence is so plain that further comment as to the relative value of the different sprays seems unnecessary.

Conclusions. A study of these data as a whole justifies the conclusion for the Hudson valley at least that in normal years when the crop is abundant or fairly abundant, one thorough early spraying, within a week or ten days after the blossoms fall, should result in the production of 95 to 98 per cent of sound fruit. A slight gain will accrue from a second treatment about three weeks later, and an additional gain from the third treatment given the latter part of July. The benefit from the latter two sprayings is comparatively small so far as the codling moth is concerned, though ample to meet the cost of the poison and, in many instances, probably the expense of treatment. Should there be sufficient fungous disease to warrant applications for this purpose, there should be no question as to the advisability of adding poison in the later sprayings.

A small crop almost invariably means a larger percentage of wormy fruit and if the prospects are even fair for good prices, the third spraying (the latter part of July) would at least justify itself because of the additional protection from possible severe injury by the second brood. The second spraying, three weeks after the blossoms fall, might be advisable especially if the first application is not thorough for some reason or other.

Fungous affections are of comparatively little importance in the Hudson valley. Many of our fruit growers have been obtaining fair results with the single treatment, and the above data, we believe, show the reason why such is the case. Comparatively few have appreciated the importance of one thorough treatment at the proper time. With the information given above we believe that our Hudson valley fruit growers can ascertain for themselves whether more than one treatment is advisable. There is no reason why the progressive fruit grower should not watch developments and if wormy apples seem to be somewhat common in early July, protect himself against possible further injury by spraying thoroughly the latter part of that month and thus destroy many of the second brood larvae before they

can enter the fruit. This second treatment would hardly be necessary more than once in three or four years, unless the light crop and high prices justified efforts to produce the largest possible quantity of sound fruit.

GIPSY MOTH

Porthetria dispar Linn.

Plates 9–12

The discovery in August last of a gipsy moth infestation at Lenox, Mass., renders most timely anything relating to this exceedingly destructive pest. A personal examination of the conditions compels us to hold that in all probability the insect was brought to Lenox with some recently set nursery stock. There was nothing in the local situation, so far as we could see, to justify the belief that the pest had been carried by automobiles. A similar infestation might easily occur west of the New York State line. This insect may be found elsewhere in the Berkshire region, or in fact in almost any place where nursery stock has been planted in recent years, provided it was grown in a locality where there was an opportunity for infestation. We hope that a careful examination of all such localities, wherever they may be, will show practical immunity from this pest. It must be recognized that this appearance of the gipsy moth in a section widely separated from the previously known infested district was to be expected and that similar infestations may develop in the future, even though there be the most careful and rigid examination of all trees and shrubs shipped out of the infested territory. There have already been, aside from the case mentioned above, several such instances. A small colony of brown-tail moth caterpillars was found in Westchester county in 1909, brought there with ornamentals grown in the vicinity of Boston, Mass. A similar condition (gipsy moth caterpillars being also present) obtained the following year in New Jersey just across the New York State line. Fortunately, exterminative measures were promptly adopted. These cases illustrate the danger of spreading both gipsy and brown-tail moths with nursery stock. It is our opinion that under present conditions we have in nursery stock a most important carrier of these insect pests to sections remote from the infested territory. A careful analysis of the situation would, in our estimation, justify the conclusion that this danger was much greater in the case of

nursery stock grown upon American soil than with that shipped from Europe, since the latter is mostly imported as seedlings, while the larger shrubs and trees receive more personal attention abroad than in this country.

(Since the above was written, a small gipsy moth infestation has been found at Great Barrington, Mass., possibly carried on a freight car, since the center of the colony appears to be close to the railroad station.)

Description. There is great danger of the gipsy moth being brought into New York State and on this account we have prepared rather careful descriptions of the various stages including also certain microscopic features of service in recognizing the insect from remains of exuviae (larval or pupal) or even broken egg masses. This latter is of considerable importance in connection with shipment of nursery stock from infested regions, since even lifeless and therefore intrinsically harmless exuviae indicate the previous occurrence of the insect upon the stock in question and compel its classification as at least suspicious.

The egg masses of this insect, occurring from midsummer till the following spring, appear very much like a small section of fine sponge. They are round or oval, buff colored and each contains usually from four hundred to five hundred eggs. The eggs may be found on stones, in tin cans and in fact on almost any stationary object near at hand, not excluding plantain leaves and other vegetation. They are especially likely to be deposited on the under surface of limbs, fence rails, moldings, etc., on or in the vicinity of infested trees. The nearly globular, pale yellowish or salmon colored eggs are about one-twentieth of an inch in diameter and are well concealed in the mass by the buff colored scales from the under side of the female's abdomen. The micropyle of this egg (plate 9, figure 2) comprises about eleven slender, irregularly pyriform plates surrounded by approximately three rows of small, polygonal plates, these in turn merging into larger, thinner, irregular, hexagonal plates. This character is of great value in establishing the identity of individual eggs or a small portion of an egg cluster. It can be demonstrated best by thoroughly cleaning individual eggs by rubbing them with the fingers in alcohol, then sectioning the egg, drying the shell and mounting it in an air cell.

The egg mass of the definite marked tussock moth, Hemerocampa definita Pack. approaches in appearance that of the gipsy moth. The approximately oval egg mass of this

insect is thinly covered with short, light buff or yellowish brown hairs and has a length of a little over half an inch. This egg mass is almost invariably deposited upon a filmy cocoon nearly one and one-quarter inches long and one-half inch in diameter and with moderately long, yellowish gray, barbed hairs entangled in the open web. The individual eggs of the definite marked tussock moth have a diameter of about one-sixteenth of an inch, are subglobular, the darker micropyle being in a marked depression and surrounded by a light yellowish brown, elevated ring, this in turn variably bordered by dark brown shading into pearly white. The micropyle of this species differs from that of the gipsy moth egg, in that there are usually but seven or eight rather stout, pyriform plates surrounded by a granular area (plate 9, figure 1).

The young gipsy moth caterpillar is slightly over one-tenth of an inch long just after it emerges from the egg. It has a black head and the brownish yellow body is well clothed with long hairs. There is a prominent hairy tubercle on either side of the segment next the head, which gives the caterpillar a peculiar, broad-headed appearance in its early stages. At this stage we find the peculiar aerostatic hairs, easily recognized by the bulb-like enlargement near the middle (plate 9, figure 6). The other hairs are distinctly barbed (plate 9, figure 5). The markings become plainer as the caterpillar increases in size.

The full-grown caterpillar is from two to two and one-half inches long and has a double row of conspicuous warts or tubercles down its back. The eight anterior, not counting the four blue ones just behind the head, blue; the twelve remaining, red. Similar tubercles occur on the side. The caterpillar of this species has large, coarse, yellowish and brown or black hairs, both minutely serrate (plate 9, figures 3, 5) and numerous finer, smaller, lighter hairs with minute reticulations on the surface. The full-grown caterpillars, like those of the well-known forest tent caterpillars, assemble in the day on the shady side of the trunks and under side of the limbs, sometimes forming clusters covering considerable areas.

The somewhat conical, dark brown pupa ranges from three-quarters to one and one-half inches long and is usually found in numbers lying among a few threads and securely attached to them by its terminal spine. The abdominal segments of the pupa are ornamented with symmetrically arranged, sparse clusters of short, yellowish hairs. Similar hairs also occur upon the thorax and at the anterior extremity of the pupa. A microscopic

preparation of a portion of the empty pupal case shows the stout, barbed hairs and on the surface of the chitin irregularly placed, oval areas apparently due to a slight increase in pigmentation or chitinization (plate 9, figure 7).

The male and female moths differ widely. The former is a slender, oval, brown, black marked insect with feathery antennae and a wing spread of about one and one-half inches. It flies in the late afternoon and early evening. The female is much heavier and lighter colored. She has a wing spread of about two inches, is white or buff white and with more or less distinct, black markings, the abdomen being tipped with black.

Distribution in America. The gipsy moth is now well established in five of the New England states. Aside from the large colony found two years ago at Wallingford, Conn., and two small ones in the Berkshires, it is not known to occur west of the Connecticut river. Both Connecticut and Massachusetts have undertaken to exterminate these outlying colonies, and it is to be hoped that the gipsy moth may be kept for a long series of years east of the Connecticut river. This stream forms a natural barrier, the absence of thick forests and the large, open valley rendering it comparatively easy to check the progress of this enemy.

Condition of infested territory. There is no better way of comprehending what infestation by the gipsy moth or the brown-tail moth means than by a study of the conditions in the infested territory. It was our pleasure, in company with parties in charge of Government, State and private work against both the gipsy and brown-tail moth, to study the problem over a wide section of country. We have also seen representative infested areas almost annually for over twenty years and, as a consequence, can make personal comparisons between the present and earlier status. Generally speaking, there has been much progress in controlling the insects in the immediate vicinity of Boston, in the towns and cities where the pests have been established for a number of years. The residential areas as a whole are in excellent condition and, to the casual observer, appear free from any very destructive insect pest. This relatively desirable change has been brought about only by enormous expenditures. It has been recently estimated that the cost of control work in Massachusetts and portions of other New England states amounts to upwards of a million dollars a year. This makes no allowance for the actual damage inflicted. Such ex-

tended and thorough work means heavy appropriations, practical only in the more valuable residential or business territory and utterly beyond the resources of poorer cities and towns having extended tracts of low-priced lands. The discrimination of an entomologist is not needed to note the widespread and in some instances extremely severe devastations by both the gipsy and the brown-tail moth (plates 10, 11, 12 and 13). The Federal Government has in recent years been spraying strips two hundred feet wide on each side of the more important highways for the purpose of preventing spread by vehicles and incidentally this serves in a considerable measure to obscure the extent of the injury. Last summer there were hundreds and in some instances thousands of acres of woodland defoliated, although the strips along the highways were in excellent leaf, due to the thorough spraying with poison. These large areas of stripped forest or orchard lands show what would be the result were there a relaxation of control measures in the well-protected territory. In other words, relative immunity is extremely costly.

The conditions would be much worse than obtain at present, in spite of the enormous expenditure, were it not for important advances in methods during the last few years. The development of very efficient high-powered spraying outfits has materially reduced the cost of spraying and made it possible to protect woodlands, in large measure, for about $7 an acre. It has been found that pure or unmixed plantings of pine, if protected from invading hosts of caterpillars, are immune from injury (plate 12). Ash is not troubled by the gipsy moth, while the work of the last two years has shown that maple, hickory and locust are rarely damaged. Chestnut also appears to suffer but little if the young caterpillars have nothing else to feed upon. Apple, oak, birch and willow are favorites of both gipsy and brown-tail moth caterpillars and under favorable conditions may be the indirect cause of serious injury to adjacent, relatively immune trees.

There is also the possibility that the numerous parasites imported during the last few years may shortly prove efficient aids in checking these pests. It should be understood that conditions in the infested district are serious, especially in sections where low values prohibit expensive control measures.

Means of preventing spread. The prevention or hindrance of the spread of such an insect as the gipsy moth is most important and in large measure practical. The female does not fly and as

a consequence the pest depends largely for dissemination upon the eggs or caterpillars being carried. The former may be readily distributed, since they are deposited upon a variety of materials, such as tree trunks, stones, bricks, boxes, crates, tin cans, and in fact almost any hard object near an infested tree or plant. Even railroad cars standing near infested trees have been burdened with eggs. Fortunately, there is a considerable chance that packing boxes, building materials, etc. will, if transported and infested, not be in the immediate vicinity of a desirable food plant at the time the eggs hatch. This one factor probably accounts for so few isolated colonies being found. Railroad cars, both passenger and freight, rarely stand for any length of time near trees which may be infested or at the time of egg-hatching adjacent to desirable food plants. Consequently there is not the serious danger of spread with freight and passenger trains running in and out of the infested territory, as would seem at the first thought. On the other hand, young trees or plants bearing eggs carry with them in most instances desirable food or are very likely to be set in the near vicinity of plants upon which the caterpillars can thrive. This is the reason why infested nursery stock must be regarded as a most important factor in carrying the gipsy moth to sections remote from the infested territory.

The crawling powers of the caterpillar are limited. Recent experiments have shown that the young caterpillars may be blown considerable distances by winds, and other evidence leads to the belief that under certain conditions they may even be carried by birds, especially by some of the larger species. There was undoubtedly a considerable local spread in the early days by caterpillars which were carried on vehicles traveling out of the infested region. Almost any moving object would serve this purpose. Automobiles are particularly effective and could easily pick up hundreds if not thousands of caterpillars in a short run through infested woods at the proper season of the year. This condition prompted and justified the large expenditures by the Federal Government for the purpose of freeing roadside trees from the pests and thus preventing a wide and rapid dissemination. The adoption of this policy has greatly reduced the danger of vehicles spreading the caterpillars, though the possibility of this still occurring, were there to be a change in conditions, should not be overlooked.

GREEN MAPLE WORM

Xylina antennata Walk.

Plates 14–16

The work of this insect was very prevalent here and there in the Hudson valley from Kingston north to Fort Edward and in the Mohawk valley to Fonda and its vicinity. This species, though comparatively unknown till recent years as an insect pest, was reported as defoliating many of the soft maples at Kingston. Green maple worms were responsible for stripping trees at Red Hook according to Mr R. N. Lewis. Many such maples and adjacent willows along the river from Glenmont to Kenwood were defoliated by the light green caterpillars of this insect. Similar work was very evident from Albany north to Troy. Defoliation of soft maples was reported from the vicinity of Hoosick Falls and it was stated that all the soft maples on the island near Fort Edward were similarly affected. Many soft maples in Schenectady and adjacent Scotia were attacked, the caterpillars appearing about May 20th. June 1st it was stated that there were about three inches of half-eaten leaves lying along the gutters in Mohawk avenue. There was also serious injury at Amsterdam in front of St Mary's Hospital on Guy Park avenue (plate 15) and in that vicinity. There were in this immediate region some fifty trees almost entirely defoliated with many more to the east showing signs of having been rather badly infested. June 9th caterpillars were not very abundant, though the statement was made that they had been excessively numerous prior to a three days' rain on the 5th to 7th, inclusive. The work of this insect in the vicinity of Albany and at Amsterdam is shown in plates 14–16.

Previous history. A similar outbreak on the soft maples at Schenectady occurred in June 1898, at which time many caterpillars were to be seen upon the affected trees and crawling upon the sidewalks and adjacent roads. There was also injury that year in a number of other localities. Outbreaks by this insect caused several complaints last year. There are comparatively few early records of damage by this species, though the caterpillars are frequently seen in orchards sometimes in numbers, and in 1896 on account of their prevalence under such conditions were denominated green fruit worms by the late Professor

Slingerland. The injury to fruit trees, however, appears to be slight compared to the damage to ash and maple trees.

Description. The moth (plate 17, figure 1) is ashy gray with indistinct, rather variable markings. There is such a close resemblance existing between this species and X. laticinerea Grote and X. grotei that only an expert in the group can reliably separate the three forms.

The caterpillars (plate 17, figure 2) are stout, smooth, light green, measuring from one to one and one-half inches in length when full grown and resembling in a general way, aside from color, some of our common cutworms. The head is pale yellowish green; there is a rather broad, yellowish white or white dorsal stripe along the body, a narrower, white subdorsal stripe, a broken, faint lateral stripe of the same color and an irregular, white stigmatal stripe, the upper margin of the last much broken or indentated by the body color. The tubercles are rather large and white and the skin is minutely spotted with the same color.

Life history. The caterpillars are not usually observed till the latter part of May or early June. They complete their growth some time in June (the past season it was early in June), enter the ground and transform to brown pupae an inch or more below the surface. They remain in this stage till September when most of the moths emerge. Though some hibernate as pupae, the majority winter as adults. It has been stated that in the South the eggs are deposited on the under surface of the leaves. No record of the oviposition in the North has been made.

Food habits. This insect evidently displays a marked preference for soft maple, though it frequently defoliates adjacent willow and maple. It is also well known as an apple tree insect. Doctor Riley has recorded injuries by this species on peach, oak galls, hickory leaves and those of other forest trees. It has been stated that it feeds also on rose buds. The late Professor Slingerland, in his bulletin, adds to the above, peas, plums, currants and quinces, and states that one grower found it necessary to watch the buds on grafted pears in order to prevent their being destroyed.

Natural enemies. Two Hymenopterous parasites, Mesochorus agilis Cress. and Meteorus hyphantriae Riley, and a Dipterous parasite, the red-tailed Tachina fly, Winthemia quadripustulata Fabr. have been reared from this caterpillar. The last-named species is one of the most ef-

fective enemies of the army worm, Heliophila unipuncta Haw.

Last season numerous birds, sparrows and robins in particular were observed at Amsterdam here and there upon the ground searching out and devouring the pests. One greedy robin was seen with three green fruit worms in his mouth. The birds were much more numerous among and under the infested trees than in other portions of the city. Only a relatively slight increase in their number would probably have checked the pest before the trees were defoliated. Dr W. G. VanName, zoologist of the State Museum, visited Amsterdam June 10th and made the following observations:

The green maple worms were then already much reduced in numbers, and it was evident that if the rate at which they were being destroyed by birds should continue, few would be able to transform to the pupal stage. Nine species of birds were actually seen eating or carrying away caterpillars, and nine others were apparently associated in this work. Considering the number of individuals, size and habits of each of the species seen eating worms, the following were apparently most destructive and in about the order named: English sparrow, robin, crow blackbird, Baltimore oriole, cow bird, cat bird, chipping sparrow.

The English sparrow takes first place solely on account of its superior numbers; the robin, cat bird, crow blackbird and oriole are individually more efficient. The cedar waxwing and yellow warbler were also seen carrying off caterpillars.

The following species, seen about or under the infested trees, were doubtless there for the purpose of feeding upon the pests: blue bird, rose-breasted grosbeak, red-eyed vireo, warbling vireo, bobolink, redstart, song sparrow. The king bird and phoebe were also seen, and though they feed chiefly on flying insects, appear to take some of the caterpillars, though this could not be established with certainty.

The majority of the above-named birds had nests within two or three hundred yards of the infested trees and could be seen carrying off the caterpillars (the robins and blackbirds often with two or three at a time) to feed their young. The caterpillars were evidently a great attraction to the birds, since there were at least two or three times as many birds as in apparently equally favorable though uninfested localities.

The following record, made between 9.30 and 10 a.m., will give an idea of the rate at which the birds were destroying the

caterpillars, the numerals indicating the number actually seen eaten or carried off during the above-mentioned period, a time when the birds were less active than earlier in the morning: English sparrows 25, robins 13, cow birds 3, cedar waxwings 2, Baltimore orioles 2, crow blackbirds 1, chipping sparrows 2; total 48.

Control or remedial measures. A scrutiny of the history and habits of this insect justifies the belief that under normal conditions, parasites and birds should keep this pest under control. The recent severe, widely separated, though local outbreaks must be construed as another evidence of a deficiency in the number of insectivorous birds. These caterpillars are smooth and therefore form a most acceptable diet to many of our native species. More adequate protection to our birds must be classed as one of the most effective methods of keeping this insect in check.

Local outbreaks on the more valuable shade trees of cities and villages can be easily checked by thorough spraying with an arsenical poison, preferably arsenate of lead, using at least two pounds (15 per cent arsenic oxid) to fifty gallons of water and making the application as soon as there is evidence that a number of caterpillars are at work. Unfortunately, many such outbreaks are not detected till almost too late for the successful use of a poison. In such instances many of the descending caterpillars can be killed by inclosing the trunks of the infested trees with a low, overhanging barricade and then treating the collected larvae with hot water, kerosene or other contact insecticides. Small trees can be protected in large measure by jarring the caterpillars from them, and if sticky bands (tree tanglefoot is most efficient) are placed around the trunk and properly guarded, none can ascend to continue the destructive work.

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IRIS BORER

Macronoctua onusta Grote

Specimens of this boring caterpillar were received July 25, 1911 from Mr Waldo L. Rich of Saratoga Springs, N. Y., accompanied by the statement that about half of the Iris tubers in a bed were partly eaten by a grub. Mr J. W. Huyck also transmitted specimens from Saratoga about the same time and stated that these borers had practically destroyed a bed of Iris roots. He found over one hundred of the caterpillars in a bed about 6 x 8 feet long.

This species appears to have largely escaped the observation of economic entomologists. It was first reared from Iris by Doctor Thaxter. Henry Bird records in 1902, injury by this larva to Iris roots, and in a recent letter states that this insect is at times obnoxious in parks and on estates where large beds of Iris are used for landscape effect. The late Dr James Fletcher mentions several instances of injury in Canada in a report for the same year, while the following season Arthur Gibson gives a somewhat detailed note respecting the operations of this borer. Dr J. B. Smith also records injury by this insect.

Description. The parent moth (plate 17, figure 3) has a wing spread of about one and seven-eighths inches and is a typical Noctuid in form and color. The forewings are a variable dark purplish brown with a more or less distinct, broadly crenulate and dentate (the latter near the middle) subterminal line. The discal spot is very irregular, being narrowly lanceolate, with an indistinct, rounded, lobelike projection anteriorly. Near the basal third and a little behind the anterior margin there is an irregularly subtriangular area bounded by a narrow line of dark scales. Posterior of this there is a faintly outlined, oval area resting upon a somewhat more distinct, curved line of dark scales, and near the posterior margin a somewhat indistinct, V-shaped mark of similar scales. The anterior third of the wing back to the middle, and the distal fifth especially on the posterior two-thirds, is markedly darker, the margin with a distinct

crenulation of darker scales. Hind wings mostly a yellowish brown with purplish brown near the tip. The thorax is thickly covered with purplish brown scales, the abdomen with light brown scales.

The pupa has a length of about one and one-half inches and a diameter of nearly one-quarter inch. It is chestnut brown, shiny. The anterior margin of the abdominal segments are coarsely and sparsely punctate, the posterior margins thickly and finely punctured. The cremaster is almost black, with two stiff, capitate spines apically and three others on each side.

The full-grown larva is about two inches long, white, the head brown and with rows of black spots laterally.

Life history and habits. The moth is secretive in habit and appears to be quite local in its operations, since Messrs Fletcher and Gibson record the work of this species in the same locality for three seasons in succession. The adults appear in the fall, September and October, and according to Mr Bird live but a short time. He is of the opinion that the eggs are laid scatteringly about the base of the Iris stalks, relying largely on the fact that winter burnings almost surely result in the local extermination of this species. He believes that the eggs hatch about the last week in May. The larvae first attack the stems some inches above the ground and gradually work downward, the full-grown caterpillars operating in the roots. Mr Bird states that the larval stages occupy a nine or ten day interval so far as he has followed them, and that there are probably six molts.

This borer has been recorded as attacking different species of Iris (all species seem to be acceptable according to Mr Bird), including the blue flag, the roots of German lily and also of the blackberry lily, Belamcanda chinensis. Under ordinary conditions this species appears to be held in check by parasites.

Control measures. Affected stems should be cut out and burned, thus destroying the caterpillars at the inception of the attack. It is probable that thorough spraying with an arsenate of lead applied about the time the insect begins operations, namely, the latter part of May, would be very effective in destroying this pest. Winter burning of the debris on Iris beds, if this can be done without injury to the roots, promises to be the simplest and most effective method of keeping this pest in check.

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NOTCH WING

Ennomos magnarius Guen.

The peculiar, linear series of polished, greenish brown or bronze colored eggs of this species on apple and pear have been received from time to time during recent years and mostly from Hudson river localities. There have been no records of serious injuries by the caterpillars, though this is a common form and a somewhat general feeder. It is widely distributed, having been recorded from northern Maine west to the Northwest Territory. It appears to be closely related to the European E. autumnaria Wernb.

Description. The individual eggs are polished, greenish brown or bronze colored, have a length of 1.25 mm, a diameter of .7 mm, subrhomboidal in shape and are deposited transversely upon the flat surface of bark side by side in linear rows. An exceptionally fine series has a length of four and one-half inches (plate 8, figure 2).

The newly hatched caterpillar is a yellowish, dark green looper with a length about 2.25 mm. The large, orange yellow head has a diameter nearly twice that of the body, the labrum and antennae being whitish. The cervical shield is moderately large, yellowish, with a deep, median, subquadrate impression, the latter fuscous greenish. The dorsum of the remaining thoracic and body segments is mostly dark olive green with a rather conspicuous lateral margin of bright yellow, the latter extending and somewhat indeterminate on the anal segments. True legs yellowish orange, venter yellowish green, the prolegs mostly yellowish or yellowish green.

According to Beutenmueller the second stage is a pale green, *smooth*, somewhat shining and without any visible mark-

ings. The third stage is characterized by yellow incisures. In the fourth stage the head and the body beneath are quite flattened, the lateral edge being ridged below the spiracles.

"The full-grown larva is a dull dirty green mottled with greenish ocherous. The head is comparatively small, and the first segment is about equal the width, the remaining segments gradually increasing in size. The thoracic feet have the bases considerably swollen and ringed with ocherous. The pair of abdominal and anal legs are chocolate brown. Over the body are scattered irregularly small, elevated, pale yellowish spots, especially on the last three segments, which are conspicuously mottled. The cervical shield is dirty chocolate brown; on the second to tenth segments inclusive, are four minute black tuberculate spots; the fourth and fifth segments have an additional pair of spots. The transverse ridge on the fifth is very prominent, as is also the one on the underside of the sixth segment and the one on the eighth segment, and the two black tuberculate spots on the dorsum of the eleventh segment. Underside of body same as above, except the last three segments pale whitish-green. Anal plates tinged with lilac. Length 110 mm." (Beutenmueller)

The pinkish white pupa is covered with a mealy substance, the extremities of the segments roughened, the interspaces being semitransparent and yellowish. The change to the pupa occurs in an oval, elongated, whitish cocoon open at each end.

The parent moth (plate 8, figure 1) is a delicate ocher yellowish insect variably marked with purplish and reddish brown, especially at the extremities of the wings, the anterior pair with a conspicuous, almost hooked lobe near the middle. The male, with its pectinate antenna, has a wing spread of about one and five-eighth inches, while the larger, stouter bodied female has slender antennae and a wing spread of about two and one-eighth inches.

Life history. Oviposition occurs in September and October, individual females depositing from five hundred to six hundred eggs. These latter hatch the following May or June, the larvae attaining full growth from the latter part of July till the end of September. The pupal stage lasts from eighteen to twenty days, adults flying from early August until the last of October. There are specimens in the Lintner collection taken at Keene Valley, N. Y., August 7, 1894.

Food habits. This caterpillar appears to be a general feeder, it having been recorded by Beutenmueller on elm, maple, sweet gum, etc. It is rather common on black birch, feeds upon poplar and, as stated above, the eggs may frequently be observed upon apple and pear. It has also been recorded on lilac and chestnut.

Remedial measures. Should the caterpillars of this species become abundant they could probably be easily controlled, as in the case of other leaf feeders, by timely spraying with a poison, preferably arsenate of lead.

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MAPLE LEAF CUTTER

Paraclemensia acerifoliella Fitch

Plate 18

This peculiar insect was excessively abundant on the estate of Dr Wilby Meyer, North West Bay, Lake George, in the town of Bolton or North Bolton. The infestation though local was severe and included perhaps twenty-five acres. Some trees had their foliage very badly injured, there being in each leaf a number of oval holes and much of the tissue between dead, because of skeletonizing by the larva. The work is rather characteristic, since the caterpillar reaches out from its oval case, eating all that is within reach and then migrates to another spot. Infested

leaves (plate 18) may therefore show one or more oval holes with circular skeletonizing here and there, the centers of some of the areas at least being occupied by an oval case, with a diameter of about five-eighths of an inch. The work is usually on the upper surface though the caterpillars occur also upon the lower side of the foliage. Viewed from below, an infested leaf is generally indicated by one or more dark spots surrounded by irregular, lighter, skeletonized, brownish areas. The injury was especially marked on the lower limbs of large trees and on small trees in the woods the feeding was confined mostly to the hard maple, adjacent soft maple practically escaping injury. A few of the larval cases accompanied by feeding were collected on oak and witch-hazel undergrowth. This latter appeared to be largely accidental. The ground was in many places thickly dotted with the circular larval cases. The late James Fletcher has also recorded rather severe injury to beech trees after the foliage on adjacent maples had been destroyed. At the time of our examination September 22d, some larvae were still feeding, though most of them had evidently forsaken the trees or were nearly ready to drop to the ground.

Previous history. Early records show this insect to be rather local in habit. The first notice of this species by Doctor Fitch states that injury was rather common during 1850 in the eastern section of New York State. The withered leaves began to be noticed in early August and continued to increase in numbers for three or four weeks. He observed that forest trees were mostly affected, those standing alone as shade trees in fields being practically exempt. This latter hardly obtained at Lake George last summer, since several badly affected trees were well separated from the adjacent woodland. The late Doctor Lintner recorded in 1888 serious injury by this insect to maples at Pittsford, Vt., nearly all the trees having the foliage brown and looking as though they had been scorched by fire. The work of this species has also been recorded from the state of Illinois, while the late Dr James Fletcher reported severe injuries to hard maples in the vicinity of Ottawa, Canada. This species appears to have a wide distribution in the northern part of the United States and southern Canada, it having been reported from New York, New Jersey, Illinois, the vicinity of Ottawa and also Kaslo, British Columbia.

Description. The small moth has been described by Doctor Dietz as follows:

Head russet-yellow. Palpi fuscous. Antennae blackish brown, pecten of first joint russet. Thorax dark brown, with golden green and bluish scales. Abdomen bronzed brown. Forewings dark fuscous, overlaid with deep, bluish purple scales; scattered over the disk and along the apical veins are some bright green, hairlike scales; both margins narrowly edged with golden. Cilia fuscous, sprinkled with bluish scales; under side fuscous brown, with purple reflection. Hind wings pale grayish fuscous, with a feeble, purple lustre, margin narrowly edged with pale metallic scales. Cilia pale fuscous; under side similar to upper. Under side of body dark fuscous, with some silver-white scales. Legs grayish, tinged with dark fuscous, basal half of tarsal joints paler.

Exp. 11.5–13.5 mm; 0.36–0.54 inch.

Doctor Fitch states that the tips of the wings are commonly bent inward, giving them when closed the appearance of a little pod enveloping the abdomen.

The pupa is about five-thirty-seconds of an inch long, pale yellowish, rather stout, the dorsum of the abdominal segments with a transverse row basally of rather stout, dark brown spines; cremaster represented by an indistinct short spine.

The full-grown caterpillar is slender, flattened, cylindric, dull white, the strongly depressed head and the third thoracic segments pale rusty brown. There is an interrupted, more or less distinct, broad, blackish stripe down the back.

The case (plate 17, figure 5) of the full-grown caterpillar is oval, about three-eighths of an inch long and composed of two pieces of a leaf fastened together at the edges and forming a shelter. Within this there is another pair of narrowly oval pieces of leaf, each with a length nearly a quarter of an inch. These are fastened together in the same way, and within this inner retreat the transformation to the pupa occurs.

Life history. Pupation occurs in the fall, and the winter is passed in the larval cases described above. These shelters usually lie upon the ground in immense numbers or fall with the affected leaves. The adults emerge and may be frequently seen, according to Doctor Fitch, during the month of May, flying by day or resting exposed upon the leaves in forests and along their borders.

Remedial measures. This species is evidently local in habit and there appears to be no reason why many of the hibernating insects could not be destroyed by burning over the ground in early fall, provided conditions admit of such treatment. It is very probable that thorough spraying, especially on the upper surface of the leaf, with arsenate of lead about the middle of June, would check this pest in a very satisfactory manner.

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LOCUST LEAF MINER

Chalepus dorsalis Thunb.

The locust leaf miner, a rather common insect on Long Island, was responsible, in large measure, for somewhat serious injury to the foliage of black locust trees at Syosset and Jericho, L. I. Mr Walter S. Funnell, editor of the Long Island department of the Brooklyn Daily Times, stated under date of August 10th that the leaves of locust trees at Syosset and Jericho were growing brown day by day, the leaves being apparently reduced to mere skeletons. Mr F. A. Bartlett of the Frost & Bartlett

Company, Stamford, Conn., reported the above species with the associated C. nervosa Panz. as doing a great amount of injury to locust trees on Long Island, many being as brown as though fire had run through them. He stated that the smaller, C. nervosa, appeared to be the more abundant of the two forms.

A personal examination of the locality September 19th showed that most of the injury was confined to trees less than thirty feet high, or to large ones in the near vicinity of this new growth. The damage was so pronounced that affected areas showed a distinct brown color, even at a considerable distance, though this had been obscured to some extent by the development of new leaves subsequent to the attack. The major portion of the injury appeared to result from skeletonizing the leaves by the beetles, the small trees noted above showing comparatively few evidences of having been mined by the grubs. A very few leaf miners, evidently belated individuals, were found.

This insect commonly occurs on large trees here and there throughout Long Island, though as a rule there is not material injury. The above described outbreak is undoubtedly irregularly periodic in character and appeared to be limited very closely to Syosset and adjacent Jericho. The trees, while checked, do not appear permanently injured and it is probable that there will be speedy recuperation.

Early history. The late Doctor Lintner, in his report for 1896, records similar injury to locust trees at Yaphank, L. I., the leaves appearing much as does elm foliage after extensive feeding by the elm leaf beetle. Doctor Chittenden states that this species is nearly always more or less troublesome to locusts in Maryland, Virginia and the District of Columbia, adding that the injury is usually most severe on young trees. Doctor Hopkins states that about 1892 thousands of locust trees died in West Virginia after the foliage had been destroyed three years in succession by this insect. The direct cause of the death of these trees, however, may have been due to abnormally cold weather. Serious damage during the seasons of 1904 and 1905 to locust trees along the Ohio river was recorded by Mr E. C. Cotton, the defoliation being general for a distance of over fifty miles, according to Mr Burgess. This insect is local in habit and appears to be decidedly more injurious in the latitude of Virginia. The late Professor W. G. Johnson reports this species as defoliating apple trees near woods, presumably locust trees.

Description. The adult beetle is about one-fourth of an inch long with the head, appendages, under surface and a median triangular area, widening posteriorly, on the wing covers coal black. The remainder of the wings and the dorsum of the thorax are orange red. The thorax is irregularly and deeply punctured and the wing covers strongly ridged and ornamented with deep, nearly flattened, thickly set rows of punctures.

The full-grown larva is a trifle over one-fourth of an inch long, with the head, thoracic shield, true legs and anal shield coal black, the remainder of the body being yellowish white; the segmentation is very distinctly marked and the abdominal segments bear conspicuous lateral tubercles, those on the second to seventh being tipped with black and with a black, chitinous point. The brown spiracles are circular.

The egg is short, oval in outline and flattened, the two sides being milk white when first laid.

The mine of this insect is equally visible on both sides of the leaf, pale green, slightly tinged with brown, its surface being slightly roughened and the margin irregularly undulated.

Distribution. This leaf beetle appears to be confined largely to the upper austral life zone. It is common throughout Long Island and probably occurs in the southern portion of the Hudson valley, at least. It has been recorded from Massachusetts, Connecticut, Pennsylvania, throughout New Jersey, Maryland, Washington, Virginia, West Virginia, southern Ohio, Kentucky, and generally distributed in Indiana and Missouri.

Food plants. The beetle feeds by preference on the leaves of the black locust. It has also been recorded as attacking the young leaves of red oak, has been found on white oak, beech, birch, hawthorn, apple, red clover, hog peanut and soja beans. The larvae have been observed in the leaves of false indigo (Amorpha fruticosa). It also occurs on several other food plants.

Life history. The beetles evidently winter in any sheltered place, and in the vicinity of Washington, at least, make their appearance as soon as the leaves of the locust trees have fully developed. At this time they eat small, oblong holes in the leaves, and later in the season skeletonize the upper surface. The eggs are laid on the under side of the leaves and are partly covered with an excrementaceous secretion. They hatch in about six to eight days, the young larvae breaking through the egg shell on the under side of the egg mass and gnawing at once

through the epidermis of the leaf. The three to five larvae in an egg mass enter through the same orifice, excavate the interior of the leaf for from two to four days, desert the mine and wander to other leaves, often to a considerable distance, where each larva excavates a retreat of its own. The number of larval migrations under natural conditions has not been ascertained. Larval existence is never less than two weeks and probably averages about three weeks. Transformation to the pupa occurs within the mine, the duration of this stage being from six and one-half to ten days. There appears to be but one generation in the northern states, while in the latitude of Washington there may be two generations. The above outline of the life history is an abstract from a more detailed account by Chittenden.

Natural enemies. This insect is subject to attack in its southern range at least, by the wheel bug, Prionidus or Arilus cristatus Linn. This large, predaceous bug preys upon the larvae while still within the mine. Trichogramma odontotae How. is recorded as a common egg parasite, while Derostenus primus How. has also been reared from the eggs and is probably a secondary parasite. Two parasites of the larvae have been recorded, namely, Sympiezus urolatae How. and Spilochalcis odontatae How.

Control measures. These must obviously be restricted to the more valuable shade trees on lawns and roadsides and, as a rule, are unnecessary in New York State. Thorough and timely spraying with an arsenate of lead, using about two pounds (15 per cent arsenic oxid) to fifty gallons of water ought to be effective in protecting the foliage. The application should be made at about the time the leaves are full grown and in New York State the advisability of the treatment must be determined largely by the abundance of the insects. Numerous beetles and slight injury to many leaves in June are liable to result in severe damage during July and early August, unless repressive measures are adopted.

Jarring the beetles into inverted umbrellas or other mechanical collectors has been suggested for a few trees in yards or lawns. This would be especially applicable to the small trees which, by the way, are the most liable to injury. This treatment would have to be repeated every few days so long as the insects continued abundant.

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ROSY HISPA

Chalepus nervosa Panz.

This small and variable leaf-feeding beetle was found associated with C. dorsalis Thunb. in an outbreak which resulted in the defoliation of many locust trees at Syosset and Jericho. Mr F. A. Bartlett of the Frost & Bartlett Company, Stamford, Conn., reported this species as more abundant than the larger and better known locust miner. For a fuller account of the conditions, the reader is referred to a discussion of the preceding species.

Previous history. This small leaf beetle is quite variable in appearance and has been described under several different names, notably, inaequalis Web. and rosea Web. It has been recorded by Chambers as mining the leaves of linden and Eupatorium ageratoides, while Messrs Hopkins and Cotton found it feeding commonly on locust in association with the locust leaf miner. Arthur Gibson states that it is common in Canada on basswood, though it has never caused noticeable injury. William Beutenmueller reared this species from the foliage of asters and Eupatorium. Harris states that these insects may be found on the leaves of apple trees and very abundantly on those of the shadbush and chokecherry during the latter part of May and

early in June. Harrington found the beetles upon oaks, hawthorns and elms, and adds that the larvae mine the leaves of various trees, including apple. Theodore Pergande reared this species from Cassia nictitans, while Messrs Hubbard and Schwarz found a pale variety or race very abundant on the leaves of Robinia neomexicana in the Santa Rita mountains of southern Arizona.

Life history. The life history of this species has been outlined by Saunders as follows:

The eggs are small, rough, blackish and fastened to the surface of the leaf either singly or in clusters of four or five.

The larvae, when hatched, eat their way into the interior of the leaf, where they feed upon its green, pulpy substance, leaving the skin above and below entire, which soon turns brown and dry, forming a blisterlike spot. The larva, when full grown, which is usually during the month of July, is about one-fifth of an inch long, oblong in form, rather broader before than behind, flattened, soft, and of a yellowish-white color, with the head and neck blackish and of a horny consistence. Each of the three anterior segments has a pair of legs; the other segments are provided with small fleshy warts at the sides, and transverse rows of little rasplike points above and beneath.

The larva changes to a pupa within the leaf, from which, in about a week, the perfect insect escapes. Within these blisterlike spots the larva, pupa, or freshly-transformed beetle may often be found.

The beetles hibernate among dead leaves and other debris.

Description. This species, according to Wickham, may be separated from allied forms by the elytral punctures being arranged in eight rows and the acute costa. He states that the color is variable, usually with the head dark, the thorax and elytra pale with dark, irregular spots.

The beetle is about one-fifth of an inch long, tawny reddish above, with irregular, darker spots and lines upon the strongly ridged, deeply punctured wing covers. The legs are yellow. These characters serve to separate it readily from the larger C. dorsalis with which it is frequently associated.

Distribution. Horn states that this beetle occurs everywhere in the eastern regions and also in Arizona. Lugger reports this beetle as common in Minnesota, it being frequently found among dead leaves and rubbish in the vicinity of forests.

Remedial measures. It is hardly likely that this species would be sufficiently numerous to make treatment advisable.

An exceptional outbreak could undoubtedly be controlled by thorough spraying with a poison as described for the preceding form. This would of necessity be restricted largely to more valuable street and park trees.

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ROSE LEAF HOPPER

Typhlocyba rosae Linn.

This common pest of roses, frequently though inaccurately designated as thrips, is an European form which has obtained a wide distribution in this country. Signs of its presence are readily seen in the series of somewhat characteristic white spots

along the midvein and in the vicinity of the other veins. These are, in the ordinary course of affairs, frequently followed by severe injury and many of the whitish or yellowish white, jumping adults. Badly infested foliage frequently has the under surface thickly specked with the white membranous cast skins of the young. This leaf hopper was exceedingly abundant and somewhat injurious to the foliage of young apple trees at Ghent, N. Y., in October 1909. This unusual attack was not unprecedented, since the late Dr C. V. Riley had earlier recorded this species as abundant on apple foliage. It has also been taken upon the leaves of plum, cultivated cherry, currant, grape, elm and soft maple.

Dr T. W. Harris, the first American to write of this species, thought that the insect might winter in the perfect stage concealed under fallen leaves and rubbish. This supposition has been repeated from time to time with no additional information respecting the life history of this species. Last winter and early in the spring the eggs of this species were found just under the bark of the new growth of rose bushes and the young issuing therefrom reared to maturity.

Description. The full-grown or perfect leaf hopper is about one-eighth of an inch long, yellowish white, the wings usually being whitish and semitransparent. The eyes, claws and ovipositor are brown.

The young present a general resemblance to the adult. They are distinctly smaller, especially when newly hatched, with only rudimentary wing pads and a very light green. They frequently harmonize so closely with the color of the under side of the leaf that it is difficult to recognize them.

The egg is semitransparent and has a length of .7 mm and a diameter of .2 mm. It is narrowly oval, the anterior extremity being broadly rounded, while near the posterior third there is a slight curve, the posterior extremity being narrowly rounded.

The eggs are deposited singly just under the new bark. Their location is indicated by an almost imperceptible, oval elevation in the bark about 1 mm long and presenting a slight greenish or yellowish discoloration occasionally accompanied by increased transparency due to the egg beneath. There is at one end of the elevation a very slight scar made at the time the egg was deposited. This wound is quite different from the elongate lenticels seen upon the wood. It is comparatively easy

to expose the eggs by simply rupturing the bark on either side with a needle and raising it. Prof. R. L. Webster of Ames, Iowa, has found the eggs of this species in the bark of elm two or three years old. He also found nymphs on maple trees though no signs of oviposition.

Life history. It is evident from the above that the eggs winter in the bark of various trees and shrubs, especially rose and probably apple. April 17, 1911 material taken at Nassau, N. Y., contained a semitransparent, yellowish embryo with a length about one-third that of the egg and showing an indistinct segmentation. May 14th nymphs were numerous on the lower leaves especially, their presence being indicated by the rather characteristic white spots along the veins. The abundant growth above the affected leaves obscures, in large measure, the early signs of this insect. The injury becomes more marked as the season advances. May 25th the nymphs were about three-quarters grown, the first adults being observed June 3d. Pairing and the deposition of eggs is stated to occur about the middle of June. Owing to the fact that the insects were not numerous later in the summer we did not follow the life history of the species further. The abundant occurrence of this leaf hopper upon apple leaves in October shows that there must be more than one generation, possibly three under favorable conditions.

Remedial measures. The hibernation of the insect in the egg stage and the consequent somewhat uniform hatching of the eggs makes it comparatively easy to watch for the early indications of injury, namely, the series of characteristic white spots along the midvein and in the vicinity of other veins, and then spray with a contact insecticide, either a whale oil soap solution or a kerosene emulsion. This application if thorough and made to the under side of the leaves should destroy practically all of the delicate, comparatively slow-moving nymphs and prevent further injury during the season unless there be an invasion from nearby plants. This early treatment will be much more effective than anything that can be employed after the insects have become adult and able to jump and fly readily.

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PERIODICAL CICADA

Tibicen septendecim Linn.

Plates 19–24

The large size of the insects, their immense numbers, the accompanying roar, the spectacular injury and unique life history, all combine to excite popular interest in the periodical visitations of this remarkable species. The season of 1911 was marked by the appearance of the large Hudson river brood, the only one occupying any great extent of this populous watershed. A Cicada colony, especially if the insects occur by the millions, abounds in interest. The early part of the visitation is marked by the numerous dirty yellow, grublike pupae leaving their burrows by the thousands in late afternoon or early evening, climbing adjacent vegetation and rapidly transforming to the beautiful yellowish white, black spotted, red-eyed insects which at this time cling to foliage and stems and appear not unlike blossoms, and by the following morning have assumed the more sombre colors of the hardened adult. Later the empty pupal shells may be seen clinging to trunks, branches and leaves, while the black, red-winged adults rest upon the foliage or sit motionless on trunk or branch. Hundreds may be driven to flight by shaking small trees. Cicada notes may herald the rising of the sun and if the day remains clear, the sound gains volume with the increase in temperature and, in the case of numerous colonies, resembles the distant hum of a busy factory. The serenade may be continued long after dark on moonlight evenings.

Life history. This insect presents an extraordinary life cycle, requiring in the northern states seventeen years to complete its transformations, though the adult existence is relatively short. The same species completes its transformations in the southern states in thirteen years. The Cicadas appear in this latitude the latter part of May, usually from May 20th to early June and may continue to July, a few persisting into August. The pupa emerges about dusk from its circular hole or burrow about half an inch in diameter and climbs the nearest support. Here it fixes itself firmly and prepares for the final transformation, which latter is an extremely interesting process and may occupy about an hour and a half. The established pupa is illustrated on plate 19, figure 1, while the first sign of the impending change, namely, a split along the back, is shown at plate 19, figure 2 and only five minutes later at plate 19, figure 3. Two minutes later we have a condition shown at plate 19, figure 4, while five minutes after the insect is half way out of the pupal shell (plate 19, figure 5) the withdrawing of the tender wings and legs from their horny cases is a matter of some difficulty and proceeds relatively slowly. One stage of this, taken seven minutes after the above mentioned illustration, is shown at plate 19, figure 6, while two minutes later (plate 20, figure 1) the developing insect had already commenced to turn back, and a minute later (plate 20, figure 2) had nearly freed its legs, this process being complete (plate 20, figure 3) 1 minute later and within another minute (plate 20, figure 4) the perfect insect was resting upon the empty pupal shell, and six minutes later (plate 20, figure 5) it was hanging beside the empty shell and the wings were beginning to develop. The developing wings are better seen in a dorsal view (plate 20, figure 6) which represents the pupa as it is turning back in an effort to withdraw its limbs, while six minutes later (plate 21, figure 1) we have the same Cicada clinging to a leaf and with its limp, milk white wings about half expanded. This latter process is rapid and the wings were nearly extended one minute later (plate 21, figure 2) and practically fully developed (plate 21, figure 3) in two minutes. The limp wings gradually stiffen and are then wrapped around the body (plate 21, figure 4). The insect hardens during the night, the wing veins become dark red, the body black and we have the well-known Cicada (plate 21, figure 5).

The adults, as demonstrated by Prof. A. L. Quaintance, feed to some extent though there never seems to be any material injury as a result. The Cicadas may be observed throughout the day resting upon the foliage or branches and occasionally flying a short distance. They seem to be very local in habit. The principal injury, as is well known, is caused by the female in the cutting of slits for the reception of eggs. This operation has been described by Mr Ira H. Lawton as follows:

After finishing one fissure the female moved slowly forward about two steps, depressed her ovipositor about 45°, and setting her saws in motion, first alternately and then simultaneously, rapidly penetrated the bark, but the ovipositor was soon elevated to 25°. After penetrating to the full length of her ovipositor and filling that chamber with eggs, she swung a little to one side and through the same hole in the bark excavated the opposite chamber and filled it with eggs. The making of each chamber occupied a little over twenty minutes or a total of forty-five minutes for the whole. During the cutting of a fissure, the saws made about eighty strokes to the minute, and after making four, the female would rest for a time. The heads of the Cicadas were directed, in the main, from the tree but not invariably so, as some worked with their heads toward the trunk of the tree.

A female with the ovipositor partly inserted is shown at plate 21, figure 6.

Oviposition. The female exercises very little choice in selecting twigs in which to deposit eggs. Mr William T. Davis of Staten Island has recorded oviposition in between seventy and eighty kinds of trees, bushes and herbaceous plants. The limbs of oaks and hickories are favorites, though on Staten Island the black birch and sweet gum were frequently severely injured. Oviposition in the twigs of pine and the smooth sumac, Rhus glabra, appears to be comparatively rare. Poison ivy is not exempt.

One female may make as many as fifty of these slits (plate 22) in a twig, and after depositing her complement, which is said to be four hundred to five hundred, drops to the earth and dies. Oviposition commenced at Nyack in 1911, according to Mr Lawton, June 22d, the eggs beginning to hatch within five weeks, namely, the latter part of July. Eggs taken in the vicinity of Albany hatched in the office August 5th. The young Cicadas are slender, grublike creatures about one-tenth of an inch long. They are as lively as ants, and after running about on the tree for a short time, drop to the ground and bury them-

selves. Their strong forelegs are well adapted for digging and are undoubtedly of great service in searching for the tender succulent rootlets on which they feed. The Cicadas grow so slowly and require so little food that but slight injury to trees or shrubs appears to result from their presence. They remain at moderate depths, especially during the ealier and latter portions of their existence though at times they have been found a number of feet below the surface. There is little change during the subterranean existence, except in size, between the newly hatched young and the full-grown nymph, which latter has on the thorax four scalelike appendages, the rudimentary wings. The insects make their way to the surface in the spring of the seventeenth year through a smooth, firmly compacted gallery which may even pierce the hard surface of a pathway or roadside and under certain conditions may be covered with a conelike chamber made of mud pellets.

Description. The periodical Cicada (plate 21, figure 6) may be easily distinguished from the common dogday Cicada or harvest fly, Cicada linnei Grossb. by the eyes and veins of the wings being bright red. More or less of the ventral surface of the abdomen (especially in the male) and the legs are dull red. The dorsal surface of the body is almost entirely black. The periodical Cicada is more slender than the stouter dogday Cicada, which latter has green markings on the thorax, greenish eyes and bright green wing veins.

Distribution. The Hudson valley brood is one of the best known, since it occurs throughout a populous section. Aside from the New York localities given in detail below, it has been recorded from Connecticut, District of Columbia, Indiana, Maryland, Michigan, the entire state of New Jersey, North Carolina, Pennsylvania, Virginia and West Virginia. An examination of the map indicating the distribution of this brood, shows that it is largely confined to the eastern slope of the Appalachian mountains, the few records in the central states apparently being isolated colonies. There are authentic records of the appearance of this brood extending back to 1724.

Comparative abundance. It is difficult to give any very exact data respecting the comparative abundance of an insect appearing only once in seventeen years, nevertheless the following observations indicate an apparent increase in some localities with a reduction in others, compared with the brood appearing in 1894. The Cicadas were about the same at Copake Falls

(H. D. Harvey) and less numerous at Ghent (Thomas F. Hartigan); equally numerous at West Taghkanic (S. S. Simmons); there were slight changes in the infested territory at Annandale (H. D. Lewis); hardly as abundant at Fonda (Frank Jansen); equally abundant or more numerous at Middletown (Eugene Smith) and at Mountainville (R. G. Doxey); twice as abundant at Goshen (C. B. Coleman); much more numerous at Schaghticoke (Fred M. Askins); somewhat more numerous at Highland (W. D. Tallman); not so abundant at Marlboro (H. C. Dawes); equally numerous at Milton (A. E. Bell); more abundant at Port Ewen (Silvanus VanAken); more abundant at Saugerties (C. E. Davis); equally numerous at Walkill (J. T. Halmes) and fewer at Thomson (Letitia H. Dixon).

There were undoubtedly a number of localities where the insect failed to appear this season though present in 1894. Most of these might easily be explained if we knew all the facts. Mr W. T. Davis, of New Brighton, states that in 1877 there were a great many Cicadas in the garden of the home place, and though the same fruit trees are standing and the conditions as regards vegetation have remained practically unchanged, yet he failed to find any of the insects the past season. He concludes that they have undoubtedly been exterminated by the house sparrows which have become very numerous in that section of Staten Island. The destruction of forests and the death or removal of shade and fruit trees is bound to result in the local extermination of the Cicada. Many such instances have doubtless occurred in the vicinity of growing cities and villages. Weak colonies are also very likely to become exterminated by birds. Mr Silvanus VanAken of Port Ewen states that the insect has failed to appear in some localities where it occurred seventeen years ago. No statement is given as to the cause. Mr Eugene Smith of Middletown states that there were great differences locally in the numbers of the insects. Practically all the others reporting upon this question concur in stating that the insect has not failed to appear in any locality where it occurred in 1894.

The relative abundance of the insects in limited localities at least, is indicated by the number of holes made by the pupae as they emerge from the ground. In some places the insects were so numerous as to literally give a honeycombed appearance to hard surfaces. This phenomenon was reported by the follow-

ing: S. S. Simmons, West Taghkanic; H. D. Lewis, Annandale; E. P. Wheeler, New Hamburg; J. H. Mills, Rhinecliff (roadside honeycombed); Eugene Smith, Middletown; R. G. Doxey, Mountainville; C. B. Coleman, Goshen (twenty-five holes in one square foot); Fred M. Askins, Schaghticoke; A. E. Bell, Milton; C. E. Davis, Saugerties; J. T. Halmes, Wallkill; N. D. Rand, West Camp (one thousand holes in twenty-five square feet); C. W. Hyatt, Peekskill, and Annis E. Thomson, Yonkers.

Time of appearance. The periodical Cicada is most remarkable because of the regularity with which it deserts its subterranean retreats. A careful study of this insect in 1894 led the late Doctor Lintner to decide that the first specimens appeared above ground May 20th, though it subsequently developed that adults emerged that year May 19th on Staten Island. Miss Annis E. Thomson, Loweree Summit, Yonkers, states that the first Cicada pupa appeared above ground last season May 13th, transforming to the adult the next day. The thin, rocky soil of that locality probably explains this somewhat early emergence. Mr Davis states that the first Cicada appeared on Staten Island May 22d. Mr George A. Lintner transmitted to this office a living specimen taken at Summit, N. J., May 20th, while Mr Ira Lawton reported the occurrence of perfect insects on that date at Nyack, Mr R. G. Doxey at Mountainville and Mr Samuel H. Cox at Bangall. Mrs Matthew Hart recorded the appearance of Cicadas at Castleton May 22d, while Mr N. D. Rand observed them at West Camp May 23d. They were observed at Annandale, Arlington, and Saugerties May 24th by Messrs H. D. Lewis, W. H. Hart and C. E. Davis, respectively, and reported from near New Baltimore Station by C. H. Van Orden May 25th. They were seen May 27th at Athens by Mr O. Q. Flint and the following day at Ravena and Fonda by Messrs Bronk VanSlyke and Frank Jansen, respectively. The first specimens taken in the vicinity of Albany were found May 29th at the Rural Cemetery and were evidently among the first to come above ground, though it is possible that a few emerged on the 28th.

It will be seen by scanning the above dates of appearance that they were progressively later as we ascend the river, with the exception of the appearance at Castleton May 22d. There may have been some local cause for this apparent irregularity.

Several instances of accelerated or delayed emergence were

brought to our attention. Mr H. D. Lewis of Annandale states that he observed a few living, fully developed Cicadas and several recently vacated pupal shells in 1910. The arrival of the main body in that locality in 1911 was later than in 1894. He found that the first appearing individuals seemed to be diseased and lived only a few hours, possibly dying as a result of adverse weather conditions. Mr J. H. Mills, Rhinecliff, also stated that many died shortly after leaving the soil.

There is another record of Cicadas appearing in 1910 in New York State, though this latter appears to apply to a different brood. Mr William T. Davis of Staten Island states that he found the insects abundant at Half Way Hollow near Wyandanch, L. I., in 1910, though repeated examinations in that locality last season failed to disclose any signs of the insect. He is inclined to believe that this appearance represents another brood which can hardly be the case with the few found in 1910 by Mr Lewis at Annandale.

Date of the first cry or song of the male. This, like the record for the last appearance and last recorded note, varies considerably, ranging in the different localities from May 22d to June 5th. The detailed records are as follows: May 22d, R. G. Doxey, Mountainville; May 25th, S. S. Simmons, West Taghkanic; May 27th, H. D. Lewis, Annandale; June 5th, Frank Jansen, Fonda; May 29th, Eugene Smith, Middletown; May 23d, C. B. Coleman, Goshen; June 10th, W. D. Tallman, Highland; May 27th, H. G. Dawes, Marlboro; May 30th, Silvanus Van-Aken, Port Ewen; May 26th, C. E. Davis, Saugerties; May 27th, N. D. Rand, West Camp; May 22d, C. W. Hyatt, Peekskill and May 30th, Annis E. Thomson, Yonkers.

Persistence of Cicadas. It is well known that the Cicadas remain above ground for several weeks, and in connection with ascertaining the distribution of the insect, two queries were asked designed to supply data respecting the period during which these insects could be either seen or heard. Parties reporting gave the date when they last saw the insect from June 12th to July 18th. The individual records are as follows: July 4th, R. G. Doxey, Mountainville; July 8th, S. S. Simmons, West Taghkanic; July 18th, H. D. Lewis, Annandale; July 4th, E. P. Wheeler, New Hamburgh; June 12th, Eugene Smith, Middletown; July 2d, C. B. Coleman, Goshen; July 4th, Sylvester Bulson, Stony Point; July 19th, W. D. Tallman, Highland;

June 21st, H. C. Dawes, Marlboro; July 1st, Silvanus VanAken, Port Ewen; July 8th, C. E. Davis, Saugerties; July 12th, N. D. Rand, West Camp; July 6th, C. W. Hyatt, Peekskill, and June 13th, Annis E. Thomson, Yonkers.

The date when the last cry or song of the male was heard is also of value in determining this period, it ranging from June 10th to August 2d or 6th. No one conversant with the party can question the record given by Mr Davis, though there is a bare possibility that Mr Bulson may have been mistaken. The detailed records are as follows: July 12th, S. S. Simmons, West Taghkanic; July 14th, H. D. Lewis, Annandale; June 12th, Eugene Smith, Middletown; July 8th, C. B. Coleman, Goshen; July 10th, W. T. Davis, New Brighton, S. I. (he records hearing a belated individual August 2d); August 6th, Sylvester Bulson, Stony Point (one male nearly over his head); June 27th, Silvanus VanAken, Port Ewen; July 8th, C. E. Davis, Saugerties; July 6th or 7th, C. W. Hyatt, Peekskill, and June 10th, Annis E. Thomson, Yonkers.

Above-ground chambers. These peculiar structures which excited so much attention in 1894 could doubtless have been found in many localities the past season. Mr H. D. Lewis of Annandale reports their rare occurence in a few places; Mr C. B. Coleman, Goshen, found a very few; Mr R. G. Doxey, Mountainville, observed them in low spots; Mr. W. T. Davis of New Brighton, S. I., states that they were rather common in the William Brook woods; Mr Silvanus Bulson found them numerous at Stony Point. Investigations at New Baltimore and at the Graceland Cemetery in the vicinity of Albany showed these above-ground chambers to be rather common though, as a rule, they were not nearly so perpendicular as appears to have been the case in 1894. On scraping away dead leaves the chambers were to be found mostly in an oblique or horizontal position, a few being vertical (plate 23). We fail to find even one locality where they were so numerous as represented by the photographs of the late Doctor Lintner, taken seventeen years ago.

The variety Cassinii appears to have been nearly overlooked though Mr William T. Davis of Staten Island records finding small numbers of this form June 16th near Willow Brook and Westerleigh. Mr Isaac Wort, Rossville, gave Mr Davis two specimens taken by him in that locality June 18th.

Appearance of the Cicada in the Hudson valley. The detailed records given below show that the Cicada appeared during 1911

on the western end of Long Island, on Staten Island and in practically all of the counties on each side of the Hudson river from New York City north to Saratoga and Washington counties, the northernmost limit recorded the past season being at Thomson, Washington county. The insects extend some miles back from the Hudson river, probably to the Massachusetts state line in the vicinity of Annandale and in Orange county, possibly some twenty miles or more from the Hudson river. There is, in addition, a recently discovered populous colony near Fonda in Montgomery county.

Albany county. Near Albany Cicadas were extremely abundant in Graceland Cemetery, Normansville; were heard at Clarksville by J. Shafer Bartlett; evidences of their work were observed in Coeymans near Coeymans creek from the West Shore Railroad, and they were reported from Dunnsville by the Albany Evening Journal. A complaint of injury by this insect to orchard trees was received from Mrs E. K. W. Vanderzee who lives near Feura Bush. Cicadas were very abundant at Kenwood just south of Albany and numerous in Wildwood valley and probably other sections of the Albany Rural Cemetery at Menands. The insects appeared to be rather generally distributed in Ravena here and there southward to the Greene county line. Mr Bronk Van Slyke of Ravena states that they were present in his orchard and that seventeen years ago they were very numerous, seriously injuring it, and that on the occasion of the preceding appearance, thirty-four years ago, the insects destroyed a nearby orchard. Cicadas were reported in 1894 from New Scotland, Voorheesville and Bethlehem Center in addition to some of those named above. It is very probable that it also appeared in these localities in 1911.

Columbia county. Cicadas were reported as being present at Claverack by Mr G. G. Atwood of the Department of Agriculture. Mr H. D. Harvey writes that they were very abundant at Copake Falls,[1] near Hillsdale. Mr Thomas T. Hartigan of Ghent states that up to June 9th Cicadas had appeared in small numbers compared to those which obtained in 1894, when there seemed to be millions of the insects. Observations on the New York Central trains showed numerous signs of Cicada work from a little south of Hudson nearly continuous to North Germantown.

[1] The Copake Falls record given above refers to the colony reported in 1894 from Hillsdale.

Evidences of their work were abundant about two miles south of Germantown and three or four miles south of that station. At Kinderhook small numbers were reported in the orchards of Mr Edward VanAlstyne and William Hotaling. Mr VanAlstyne states that there was a numerous colony on another farm of his some two miles west of the home place. There were abundant evidences of Cicada work in a patch of woods about one mile south of Niverville on the Albany Southern Railroad. Scattering insects were reported at North Chatham on the farms of W. W. Woodward and Theodore Horton. Along the line of the New York Central Railroad there was evidently an abundant colony one-half mile south of Stockport and two miles south of this station they were even more numerous. The insects were also reported from Stuyvesant Falls. Mr S. S. Simmons, West Taghkanic, states that Cicadas were abundant in that locality some eight miles east of the Hudson river and only a few miles from the southwestern corner of Massachusetts.

Dutchess county. Mr H. D. Lewis reported the Cicadas as very numerous at Annandale, they appearing first May 24th. The insects were very abundant in portions of a small orchard near the residence of Mr Lewis's father, some trees being very badly infested, while less than fifty feet away comparatively few Cicadas were to be seen. The orchard some distance from the house, which was badly infested in 1894, showed comparatively few this year. Mr Lewis states that the insect occurred here and there on the ridges from the river practically to the Connecticut state line. Cicadas were excessively abundant on the estate of Warren Delano near the river. They were literally present in millions, immense numbers of pupal shells being observed clinging to the branches and lying at the base of the large oaks and maples. Probably several quarts could have been scooped up around almost any one of the trees. The Cicadas were exceedingly numerous on this estate in 1894. Mr W. H. Hart noted Cicadas for the first time in his Arlington orchard May 25th. Early plowing resulted in turning up pupae so abundant in some places that there appeared to be more insects than soil. Mr Samuel H. Cox reported millions of Cicadas in the vicinity of Bangall. They were rather numerous near the Barrytown station. Mr H. D. Lewis of Annandale states that several orchards in Barrytown were ruined, even trees set some fifteen years ago. In one instance a recently set orchard had the two rows next a badly infested woodland severely affected, while all of the other trees practically escaped injury. There were a few

signs of Cicada work visible from the New York Central tracks two to four miles north of Camelot, while injured twigs were abundant four miles north. There was evidenty a numerous colony along the New York Central tracks one-half mile north of Chelsea and extending for fully one and one-half miles. The work of this insect was most apparent on rocky knolls or hills covered with a scrubby oak growth. Cicada injury was very evident south of Dutchess Junction, while the woodland on the hills to the east appeared to be severely injured. The work of what appeared to be a moderately small colony was observed just north of Fishkill Landing, this colony being fully a mile long. At Hyde Park the evidences of Cicada work were rather prevalent, there being abundant signs of injury one-half mile south, and a little farther south the work was even more prevalent and practically continuous from that point to Poughkeepsie. Mr Everett P. Wheeler of New York states that the Cicadas became very numerous at New Hamburg and were destructive to young branches of trees, particularly peach and elm. Observations from the New York Central Railroad disclosed signs of this insect's work here and there in the vicinity. The Poughkeepsie News states that the insects were present in millions on the river road near "Carnwath," the grass was completely covered with the pupal cases, while the roar of the singing could be heard for miles. Another locality mentioned was on the Ruppert farm south of the driving park. Dr Z. D. Patterson of Red Hook states that the Cicadas were a great menace in that locality. Mr Joseph H. Mills, forester for J. J. Astor, reports an infested locality of one and one-half acres of lawn and shade trees at Ferncliff near Rhinecliff. There was on the average about four quarts of pupal shells under about twenty trees, one having five quarts within a radius of eight feet. Rhinecliff and vicinity appears to have been one of the localities greatly favored by Cicadas. The insects were present at Staatsburg, evidence of their work being plainly seen from the New York Central tracks some one-half mile south of the station, and more evident two to three miles farther south. Cicada work was abundant also at Tivoli, some trees having their tips killed while a few small ones had most of the branches destroyed. The colonies along the New York Central Railroad were practically continuous and abundant from Tivoli south to Rhinecliff.

Greene county. The work of Cicadas was observed from the West Shore Railroad about two miles north of Alsen to one mile

south, a colony nearly three miles long. The insect was reported from Athens by Mr J. Q. Flint as follows: On land belonging to Mr Egbert Hallenbeck at Morrison Hill south of Athens; on land of Mr Edward A. Guthrie on the Sporenburgh road; on that of Miss Anna Brandow on the Catskill road. The insects were exceedingly abundant at Morrison Hill and were doubtless generally prevalent in that section. They were reported as being present at Cairo by Miss Ida M. Bonesteel. Cicadas were said to occur at Leeds. Mr C. H. VanOrden reported the appearance of the insects between West Coxsackie and New Baltimore Station on the 25th, they being in full cry on the 27th. There was a large colony about a quarter of a mile south of New Baltimore Station on the West Shore Railroad. The noise was loud enough so that the insects could easily be heard a quarter of a mile. An orchard about midway between Ravena and New Baltimore Station was very badly infested by this insect and it was reported as being present a half mile or so east of New Baltimore Station. Cicada work was seen from the West Shore Railroad from about one-half of a mile to a mile and a half south of the West Athens station. The insects were reported as very abundant at West Coxsackie.

Montgomery county. A large colony was recorded by Mr Frank Jansen on the sand flats about three miles west or northwest of Fonda, the insects occurring there by the millions and making the woods ring with their noise about half a mile from his house. Mr Jansen states that he knows they were in that locality in 1894 and adds that his wife heard them on the occasion of their previous advent, namely, 1877. The local papers refer to this colony as being in Mr Nare's woods and state that the birds were devouring many of the insects. This appears to be a hitherto unrecorded locality for the periodical Cicada.

Nassau county. Miss Grace K. Wandless reported Cicadas as being abundant at Garden City.

New York county. Mr Waldemar Cruger, 85 West 181st street, found insects, presumably in that locality, and reports Cicadas as rather scarce in the Bronx. He observed fifteen to twenty on a tree at Fort Schuyler.

Orange county appears to be one of the strongholds of the Cicada, since its work was seen here and there in the woods along the river, while reports from various localities in this county agree in considering the insect extremely abundant. Many of the tips of the branches in the woods in the vicinity

of Balmville just north of Newburgh were killed by this insect. Mr C. B. Coleman, Goshen, states that it is difficult to find in that locality a farm where the insect does not occur in considerable numbers, many of the trees appearing as though they had been swept by fire. Near Highland Falls the work of this insect was conspicuous at a distance. There were millions of Cicadas, according to C. M. Dayton, at Leptondale some ten miles from Newburgh. The work of the insect was very abundant in woodlands in the vicinity of Middlehope. Mr Eugene Smith reports the Cicada as occurring in millions in the country surrounding Middletown, while press dispatches allege serious injury resulting from the work of this species. Millions were to be seen at Mountainville, town of Cornwall (R. G. Doxey). According to the Montgomery Standard there were millions of the insects along the banks of the Wallkill valley, notably in the grove belonging to Charles Mould near Bodine's Bridge. Several Newburgh papers record an abundance of Cicadas in the near vicinity of the city. South of the city they were very abundant on the Highlands and at a place about four miles north of West Point the colonies appeared to extend well toward the summit of the ridges and some distance back from the river. The Middletown Argus reports the insect at Demerest's Heights, Warwick. Cicada work was rather abundant in the woodlands north and south of West Point. Mr William T. Davis of Staten Island was at West Point June 3d and states that one of the most impressive sights was the number of Cicadas which occurred on the mountain side. They commenced singing with the rising of the sun. "Stronger and louder grew the song until it was continuous like the hum of some busy factory. This lasted till the sun went down." (Davis)

Putnam county. There appears to have been no record of the periodical Cicada occurring in Putnam county in 1894. The work of this insect was evident in 1911 here and there along the Hudson river. Injured twigs were observed on the hills just north of Cold Spring, apparently local, while a little north of Peekskill in Westchester county evidences of oviposition were observed almost continuously north to Garrison. About one mile farther north Cicada work was observed and was prevalent for a distance of some two miles. Evidences of Cicada injury were extremely abundant along the New York Central Railroad north from Cold Spring nearly to Dutchess Junction and undoubtedly including the section in the vicinity of the New York

Central station, Storm King. There are no records of the occurrence of this insect in the eastern part of the county.

Queens county. It is presumed that the Cicada occurred in small numbers in Queens county, since it was observed in Suffolk and occurred abundantly in the not distant Westchester and Richmond counties.

Rensselaer county. The presence of Cicadas at Castleton was reported by Mrs Matthew Hart. In the town of East Greenbush they occurred in large numbers northeast of the village near Elliott's Station on the Albany Southern Railroad. Mr James Elliott remembers their appearance in both 1894 and 1877. They were not so abundant seventeen years ago as in 1877. At East Schodack, they were reported by James Loweree as very abundant on the Thomas Collins' farm near the residence of John Coons and about two miles west of the village of Nassau. He states that they also occurred on the farm of Augustus Byers. Abel Merchant reports that Cicadas were numerous on Dusenbury hill about three miles east of the village of Nassau and between the residences of Joseph Miller and Stephen Miller just off from the cross road near what is known as the Cold Water Tavern. The insects occurred scatteringly in the vicinity of the village of Nassau. In North Greenbush, Cicadas were very abundant on the grounds of the Forbes Manor estate and northeast on Quackendary kill according to Julius Keastner. They were also numerous farther to the north opposite Maple Beach Park. Mr M. B. Hartley of Schenectady states that there was a large colony on the river road leaving North Troy or Lansingburg and near the shore at a point called "The Riffs." There was a rather abundant colony along the line of the Albany Southern Railroad just south of Schodack Center and also in the vicinity of Stop 77. There was a large colony near the Boston and Albany tracks one mile south of the East Greenbush flag station. Mr Fred M. Askins reported a very numerous colony in the town of Schaghticoke for about two miles along the Hudson river and south of Reynolds, the ground being honeycombed in places by their galleries. The only record we have for this county in 1894 was that for Bath-on-the-Hudson (really Forbes Manor, North Greenbush) where the insects were rather abundant.

Richmond county. Cicadas were generally distributed in the wooded areas on Staten Island (except in the small, so-called pine barren region) according to Mr William T. Davis of New Brighton who has kindly supplied us with the following data.

The insects first appeared May 22d. They were reported by Mr C. W. Leng on the 23d at West New Brighton, and on the same day by Mr Isaac West at Rossville near the other end of the island. They appeared earlier or were more numerous in some places than in others. At Great Kill they were very common in a grove of sweet gums and could be seen flying and heard singing on May 26th. There were many more males than females at that early date.

Rockland county. This appears to be another Cicada stronghold. The results of oviposition were observed on Iona island and vicinity, the insects probably covering most of the Dunderberg mountain to the south. Mr Ira Lawton reports the occurrence of the Cicada at Nyack. They were recorded in swarms near Suffern by Mr M. S. Daniels and reported by Mr Sylvester Bulson as occupying a territory about six miles square between Haverstraw and Fort Montgomery. This brood was reported by Dr J. A. Lintner in 1894 from Palisades on the Hudson and was doubtless more or less prevalent throughout the county.

Saratoga county. Rev. David C. Davies of Mechanicville transmitted specimens of Cicadas collected by himself on the Bemis Heights battlefield in the town of Stillwater. He states that there were hundreds of the pupal cases to be seen. He also sent specimens taken on the farm of George Lape, a mile and a half from Mechanicville and about a mile west of the Hudson river. The trees in this locality were full of the insects and their singing could be heard for some distance. He also states he heard of a colony on the east side of the Hudson and northeast of Stillwater in a locality known as Chase's Hill, a place where they appeared in 1894. The local press records the appearance of great numbers of the Cicadas on the Guy Fitch farm about three miles northwest of Mechanicville. Mr George B. Thomas observed Cicadas about four and one-half miles south of Schuylerville and one-quarter of a mile west of the Hudson river. There was a clump of bushes and trees about one rod wide and twenty rods long which were nearly covered with the insects.

Suffolk county. Mr William T. Davis, of New Brighton, states that occasional Cicadas were found in localities on the western end of Long Island. He adds that he was unable to find any specimens whatever after three visits to the Half Way Hollow Hills where the insects were so abundant in 1910, and he is therefore led to conclude that this earlier appearance represents an independent brood. Mr Charles Watkins of Wyandanch in-

formed Mr Davis that he had seen two Cicadas (in 1911) in the nearby lowlands, and Mr Frederick M. Scott assured Mr Davis that he had heard a few singing about the village but never in the hills. Mr Davis visited Babylon, L. I., on July 21st and was unable to find any one who had seen Cicadas reported from that vicinity by the Brooklyn Eagle. We have been unable to obtain any other records respecting the occurrence of this brood upon Long Island in 1911.

Ulster county. Just south of Esopus station many locust trees along the West Shore Railroad showed the effects of Cicada work, and the same was true of oak about one mile farther south. At Highland the insects were reported extremely abundant in the woods near the station, though no injured twigs were observed. Mr H. W. Ford reported, under date of July 5th, hearing only a few of the insects. Mr W. D. Tallman states that the insects were rather abundant at Highland and that they appeared in small numbers one-half mile west of Clintondale, some seven miles from the Hudson river. They seemed to be more abundant than in 1894. Many dead tips were observed from the West Shore Railroad one-half mile south of Malden. Cicada work was very abundant in the woods just above Marlboro, the colony being more or less continuous from there to Milton where similar conditions obtained. Mr H. C. Dawes, three miles south and west of Marlboro, found Cicadas very scarce in his neighborhood. Mr Arthur E. Bell of Milton reports the insect about as abundant as in 1894 and is of the opinion that it did not fail to appear in any locality where it occurred that year. Serious injury resulted in some places. Many Cicadas were reported from the woods back of New Paltz. Dr J. R. Gillett May 30th stated that the insects occurred all along the line from Highland to New Paltz. About one-half square mile of mountain land was abundantly infested by the Cicadas at Port Ewen according to Silvanus VanAken, the insects failing to appear in some localities where they occurred in 1894. Very little injury came to his notice. He reports another colony one and one-half miles southeast of Port Ewen. Miss Ethel H. Dann observed great numbers of Cicadas at Saugerties. Mr C. E. Davis of that locality states that there is an infested area some six miles from Saugerties and one mile west of the Hudson, the insects occurring by the millions and so abundant that it was necessary to lead horses in cultivating crops. Mr William Waldele, Saugerties, reports the Cicadas so numerous

that nearly every leaf, limb and part of recently set apple trees were covered with the insects. Mr J. T. Halmes, writing from Wallkill, states that June 30th the Cicada cry was almost continuous, especially when crossing the Shawangunk mountain between the Wallkill valley and Ellenville, the cry apparently stopping as he entered Sullivan county. Returning to Wallkill three weeks later he observed that the insects had disappeared and that the oaks and chestnuts especially had been severely injured, it appearing as though fire had scorched the young branches. Mr N. D. Rand of West Camp reports an infestation one-quarter of a mile wide along the Hudson, the insects occurring by the millions and extensive injury to apple and peach trees in particular, resulting. Just south of West Camp station on the West Shore Railroad injuries by Cicada were very evident. This insect was recorded by Dr J. A. Lintner in 1894, in addition to certain localities given above, from Quarryville.

Washington county. Miss Letitia H. Dixon transmitted specimens collected in Governor Dix's woods at Thomson and states that the insects were there seventeen years ago. Mrs William G. Drake, now of New Jersey, informs us that she remembers very well Doctor Fitch collecting periodical Cicadas in 1877 at Fort Miller, only a short distance from Thomson. There appears to have been no published record of this occurrence in 1894.

Westchester county. Mr R. W. Trine is responsible for the statement that Cicadas were thick on his property, "the Kitchawan Hills," Croton Lake, located on the Mount Airy road to Croton. The insects did not occur in the village though they were pretty generally distributed in that section. Mr G. G. Atwood of the Department of Agriculture reports the insect very abundant at Dobbs Ferry and Katonah. Messrs Edward and Robert Broom of Mount Vernon record many pupal cases in that locality. Mr A. J. Bolton of New Rochelle reports large numbers of Cicadas, probably millions, on Twin and Hunter islands. The insect was also reported as occurring by millions at New Rochelle and in the Pelhams. Mr C. W. Hyatt found Cicadas abundant about four miles north and three miles west of Peekskill. Mrs E. H. Kingsland reports thousands of Cicadas at Pelham. Abundant evidences of this insect were observed from the New York Central tracks just north of Ossining, injuries being rather numerous from there to Croton on Hudson. From Scarboro along the New York Central tracks south nearly to Tarrytown evidences of Cicada oviposition were rather abund-

ant. Miss Annis E. Thomson, of Yonkers, reports thousands of Cicadas at Lowerre Summit and Park Hill. It is probable that the insect was pretty generally distributed throughout the western and southern portion of the county, at least.

Natural enemies. A large and excessively numerous insect such as the Cicada affords abundant provender for many natural enemies. Cats and dogs have been reported as eating the pupae as they emerge from the ground. Miss Annis E. Thomson of Yonkers reports feeding twenty of the insects in succession to a cat without any ill effects. Skunks, groundhogs and gray squirrels have been observed in earlier years feeding upon the Cicadas, and it is probable that several other quadrupeds do not ignore this article of diet. There were several reports of domestic fowls, probably all kinds, feeding greedily upon the insects. Birds, such as hawks, crows, robins and sparrows, feed readily upon this species. More than one farmer reports no pulling of corn and unharmed cherries as a result of abundant Cicadas in the vicinity. A flock of crows hanging over a woodland and scolding on the approach of man, is very likely to signify a colony of Cicadas. The English sparrow appears to be particularly fond of this insect and is undoubtedly largely responsible for its local extermination in the vicinity of cities.

There are several insect enemies of the Cicada. Mr J. C. Guffin, Albany, reports having observed one of our largest dragon flies feeding upon a Cicada. His attention was attracted by the Cicada note and sounds of a struggle. An investigation disclosed the two insects on a nearby mullen stalk. The dragon fly was seen to bite off the head of the Cicada, eat into the thorax, and after a time, becoming alarmed, fly away with the remainder of the body. Mr O. Q. Flint, Athens, reported darning needles numerous in the vicinity of a locust colony. Ants have also been observed to attack Cicadas though they probably content themselves with preying on the dying or dead.

The fungus Massospora cicadina was reported rather prevalent in a number of localities. Mr William T. Davis of Staten Island found numerous males and females infected with the disease at West Point June 3d. It was observed in Graceland Cemetery near Albany as early as June 9th, while at New Baltimore it was rather prevalent June 10th and 13th. Occasional specimens could be seen flying even after most of the abdomen had dropped off as a result of the fungous infection. Mr R. G. Doxey, Mountainville, reports the occurrence of the

fungus. Mr H. D. Lewis of Annandale recorded many dead and dying insects, some infected with fungus June 16th.

The local presence of the disease was also reported by Mr S. S. Simmons, West Taghkanic; Eugene Smith, Middletown; C. B. Coleman, Goshen; Fred M. Askens, Schaghticoke; Sylvester Bulson, Stony Point and C. W. Hyatt, Peekskill.

Adverse weather conditions are undoubtedly responsible for the untimely death of many insects. Miss Annis E. Thomson states that on June 10th, 11th and 12th there were three terrific thunder and lightning storms which killed *every* Cicada. Not one was seen alive after June 12th. Between the storms, the birds feasted on the insects and the children picked the wings from the multitude of dead bodies in the roadways.

Injuries. The reports of injuries as a result of a Cicada visitation usually characterized the damage as very severe, and in localities where the insects are exceptionally numerous, many of the young twigs, in some instances most, may be killed by the numerous oviposition scars. This looks badly in midsummer and gives a very unfavorable impression, whereas in reality the damage is confined largely to the small limbs, and in the case of good sized trees amounts to but little more than a somewhat general heading back. Some correspondents state that affected trees look as though they had been swept by fire. In certain cases fruiting trees had the limbs so badly injured that they broke with the weight of the young apples. The proportionate injury to young trees is undoubtedly much greater than in the case of large ones, and in certain instances may result in the ruin, if not death, of individual trees.

The Cicada is relatively local in its habits, and as a consequence the injury is rarely widespread and mostly confined to comparatively low value forest trees. This disinclination of the Cicada to fly is well illustrated by conditions obtaining on the farm of Mr H. D. Lewis at Annandale. There were a number of trees in one orchard very badly infested with the insects while within fifty feet there were many others practically free from Cicadas. Mr Lewis reports one case where two rows of a young orchard near a woodland were severely affected, while other parts were practically free from damage. Mr R. G. Doxey, Mountainville, records the killing of newly set fruit trees.

Preventives of injury. The major portion of the visible injury at least is caused by the female as she makes slits in the twigs with her sawlike ovipositor for the reception of eggs. It

is purely a mechanical injury. Small trees in the vicinity of a numerous colony can be easily protected by inclosing them with a fine netting during this egg-laying period (plate 24). It is equally obvious that some attention to the probabilities of injury in the future would suggest refraining from planting young trees near infested woodlands for at least several years prior to the expected appearance of the insect. Similarly, trees in the locality where Cicadas were abundant might well be trimmed very little or not at all for one or two years prior to the advent of the insects, thus leaving a superabundance of wood and mitigating to considerable extent the probable injury.

Practical experience has shown that it is possible by systematic and persistent collecting to protect moderate sized trees from serious injury. The adoption of such measures would be justified only by some exceptional conditions. Their efficacy depends largely upon the somewhat local habits of the insect.

Spraying the issuing pupae with a contact insecticide, such as a kerosene emulsion, whale oil soap solution or other material will destroy immense numbers, and where the insects are exceptionally abundant and the trees valuable, may be profitable. Mr H. D. Lewis of Annandale reports that spraying trees infested by the insects, with a commercial lime-sulfur solution diluted one part to forty appears to drive out the Cicadas. This method might prove of value in the vicinity of woodlands and assist in keeping the insects restricted largely to the wild growth. It is possible that spraying with a lime-sulfur wash, as mentioned above, or with a bordeaux mixture, may prove of considerable service in preventing oviposition.

Bibliography

Very many popular notices, accurate and otherwise, have appeared in the press of the country during the past season. The insect has also figured in many scientific accounts from time to time. The following brief bibliography, in connection with the citations the works contain, will enable the student to ascertain the more important facts respecting this remarkable species.

1897 **Lintner, J. A.** Injur. and Other Ins. N. Y., 12th Rep't p. 272–98.
1905 **Felt, E. P.** N. Y. State Mus. Mem. 8, 1:231–37.
1907 **Marlatt, C. L.** U. S. Dep't Agric., Bur. Ent. Bul. 71, p. 1–181.

A REPORT UPON THE CONDITION OF THE SHADE TREES OF THE CITY OF MOUNT VERNON, N. Y.

The Entomologist, under the guidance of Alderman Whitmore and Commissioner of Public Works Harlow, examined the shade trees of Mount Vernon Tuesday afternoon, June 20, 1911. It was obviously impossible to make a careful examination of all the injured trees in the city. Our investigations were therefore limited to what were considered typical localities. At the outset we were informed that some 2136 trees were sprayed last spring, largely for the purpose of controlling the false maple scale.[1] Many of these, mostly hard maples, show signs of severe injury from one cause or another.

An examination of the trees disclosed the fact that the leopard moth[2] is generally present in the city and, furthermore, that it is liable to cause, if allowed to breed unrestricted, serious injuries within a few years. We observed no maples so badly infested with this insect as to justify holding the pest responsible for the recent and sudden death of individual trees, or even of good sized limbs, though we did find certain trees, mostly soft maples, which were rather badly infested by this species.

Our investigations also showed that a "pin-hole" borer[3] or "Ambrosia beetle" is generally present on the dead and dying trees. This insect is just entering the maples, attracted by their unhealthy condition and therefore can not have a causative relation to the present sad state of many hard maples in Mount Vernon.

There was also found on a number of these trees, a moderate sized, reddish-brown, yellow-marked beetle,[4] which, like the "pin-hole" borer, is an inhabitant of diseased or dying trees.

At Park avenue and East Sibley street, near the church, there were fifteen out of about twenty hard maples with at least the lower limbs seriously affected, a few of the smaller having practically all the foliage destroyed. The type of injury observed here was limited to trees marked or recorded as having been sprayed. We were informed that this was done in March.

[1] Phenacoccus acericola King.
[2] Zeuzera pyrina Linn.
[3] Xylotcrus sp.
[4] Neoclytus erythrocephalus Fabr.

These maples were young trees which presented every appearance of having recently been in as thriving and vigorous a condition as nearby unharmed maples, which latter were not marked as having been sprayed, and no record was submitted to show that they had been so treated. These trees, both the injured and the nearby unharmed ones, were young and fairly well separated. There was no evidence of overcrowding, though this would doubtless occur later if all the trees grew and were allowed to remain.

At Park and Oakley avenues there were nineteen hard maples perhaps more seriously affected out of about twenty-six sprayed and presumably treated in the same manner as those discussed above. These trees were smaller than those in the preceding lot, and some at least of the injured maples even had the tips of their branches well separated from those adjacent. They presented every indication of having recently been in a thriving condition and there could have been no crowding for several years at least. At North Fulton and Clinton avenues most of the hard maples were killed on one block. These trees were larger than those discussed above. Even here one could hardly consider the maples crowded, though in a year or two such a condition would probably develop. One of these trees was cut down and the larger limbs, the trunk and the base of the roots carefully examined for insect and other injuries.

On Beechwood avenue in another part of the city we examined several small hard maples marked as having been sprayed. This work, we were informed, was done later and the injury was not so severe, though three out of some seven or eight hard maples were affected to some extent.

Several other trees in this general section of the city were examined. One was dying but the trouble appeared very different from the injury under discussion. The entire top was dead and there was a vigorous growth of shoots at the base of the larger limbs. This type of injury we have seen here and there in the vicinity of New York City. Another affected tree was observed. The foliage presented a generally unhealthy condition. The trouble appeared to be similar to, or possibly identical with, the bacterial affection which was so prevalent on hard maples in the Hudson valley two years ago. The condition of this tree is very different, in our estimation, from the severe

injury noted elsewhere. There are undoubtedly other trees here and there in the city which are dying from one cause or another. It would be surprising were conditions otherwise.

Our findings in connection with the major portion of the injured maples are as follows:

1 The trouble is practically limited to hard maples.

2 It is confined very largely to the lower limbs or portions of the tree most easily reached by spraying outfits of the usual type. This phase of the injury attracted our notice at the outset. Small trees, those not more than eighteen or twenty feet high, were more frequently killed than moderate sized ones. The lower branches of these latter were usually in a dying condition; sometimes the lower third or the lower half of the limbs were thus affected. On large trees, such for example as those in front of Alderman Whitmore's residence, the injury was mostly limited to a few of the lowest limbs.

3 Only trees marked as having been sprayed or so recorded, presented the characteristics common to all the hard maples showing this sudden and severe injury, namely, dying branches with withering, usually discolored leaves accompanied by a brown, lifeless inner bark near the middle portion of the branches and the trunk.

4 A careful examination of the trees in the above mentioned localities which, we were informed, were typical of conditions obtaining in Mount Vernon, compels us to exonerate insects. The injury is utterly unlike the work of any insect pest. There is no connection between the abundance of the leopard moth and the severity of the attack. Were this insect the cause we would expect the trouble to show first on the silver or soft maples. This opinion is based not only upon a superficial examination of a number of trees, but also a detailed one of the tree cut down on North Fulton avenue and also a number of limbs which were removed from various other trees.

5 The injury to the affected trees is restricted largely to the trunk near the base of the larger limbs and to the lower branches, places easily reached with the ordinary spraying equipment. Repeated examinations of dying limbs showed green, apparently vigorous bark at both the base and the tip, while for a variable length of the branch the inner bark was brown and dead or nearly so. Some limbs on the more badly affected trees had practically all the inner bark dead, simply indicating that the injury had pro-

gressed farther. Furthermore, this affection was uneven and varied greatly within a few inches, indicating that it might have resulted from some external application. This was true also of the tree cut down. The tips of the branches and the trunk below the limbs had a green, apparently healthy inner bark, while much of the inner bark between these extremes had turned brown and was dead or nearly so. We explain this condition by holding that the thicker bark of the trunk would succumb less quickly to an injurious application than the thinner bark just above. The smaller limbs, especially at the top of the tree, escaped serious injury because of the difficulty of spraying them thoroughly. The lesser injury to the later sprayed trees is probably due to the increased pressure of the sap hindering the penetration of the spray material. It is well recognized among entomologists that bark borers working near the middle of the trunk of the tree, namely, near the base of the larger limbs, may girdle the trunk at this point and cause a successive and rather rapid death of both extremities of the tree. We have repeatedly seen this in the case of bark borers[1] working in the trunks of white pine, and the same process may be observed in hickories succumbing to the injuries of the deadly hickory bark borer,[2] a pest now very prevalent in the vicinity of New York City. The spray material appears to have girdled limbs and trunks by destroying the vital inner bark and produced a condition similar to that resulting from bark beetle attack. These insects can not be held responsible for the injury, since the great majority of the affected limbs and trunks show practically no indications of insect injury.

6 It is our opinion that the trouble is largely if not entirely due to injury caused by the material sprayed upon the trees.

7 We would advise the prompt removal of the dead trees and the early burning of the wood so as to prevent "pin-hole" borers or Ambrosia beetles breeding out and possibly causing serious trouble later. We would favor leaving trees showing fair signs of vigor till it was evident that they were beyond hope.

8 The leopard moth is well distributed throughout the city and, if allowed to multiply freely, may ruin many trees. A judicious cutting out of the borers and the destruction of the

[1] Ips sp.

[2] Eccoptogaster quadrispinosus Say.

moths so far as practicable would do much to avert trouble. There are other insect pests which also need attention.

9 In conclusion, we would emphasize the fact that not all the sickly trees were injured by the application. Moreover, the majority of the sprayed maples were infested by insects and therefore less able to withstand injury. Had the season been as early as usual, it is probable that the damage would not have been so severe. Nevertheless, the use of oils or oily preparations on living plants is attended with a certain amount of danger.

EXPERIMENTS WITH HEAT AS AN INSECTICIDE

There are numerous places where it is impractical to employ gases, contact insecticides or arsenical poisons for the destruction of injurious pests, and in some of these situations heat may be available. The work of Dean[1] indicates the possibilities along this line in the case of several well-known mill pests. It seemed advisable to test this with other insects, and the heat-loving, oriental cockroach, Periplaneta orientalis Linn., was selected as presumably a very resistant form. The work began with insects in vials, then in jars and finally in jars or pasteboard cylinders in a small room. In all instances observations were possible throughout the test and the thermometers were corrected by comparison with standard instruments. Great care was exercised so to place the vials or jars containing the insects that the walls could not become unduly heated with consequent burning of the contained roaches.

The apparatus employed in experiments 1 to 3 consisted of a candy jar about eight inches high, in which was placed an ordinary stab file supported on three wooden blocks so as to separate its metal base from the glass bottom. A piece of soft pine was fastened to the tip and from this a dairy thermometer suspended so that it hung nearly in the middle of the jar and touched no metal, its bulb being nearly an inch and a half from the bottom of the jar and its top just below the cover. The insects subjected to the test were suspended in the same way as the thermometers. They were placed in two dram vials, the free end being covered with coarse cheesecloth and the vials hung so that they were nearly eight inches from the bottom of the candy jar and free from contact with any metal. The candy jar in turn was placed on wooden blocks in a shallow pan partly filled with water, protected by an asbestos mat and placed on a gas plate.

Experiments 4 and 5 differed in that a quart fruit jar was placed inside the candy jar described above. The insects were provided with a slanting piece of cardboard for a support though nothing was placed in the bottom.

Experiments 6 to 8 differed from the preceding in that the insects were better protected. Small blocks of wood were

[1] Dean, G. A. Econ. Ent. Jour., 1911, 4:142-58.

placed inside the fruit jar, and on these a circular piece of corrugated cardboard so that the latter could not come in direct contact with the glass bottom. The fruit jar, in addition, had the lower half lined by corrugated paper in such a way that it was impossible for the insects to come in direct contact with the heated glass walls. The thermometer rested lightly upon this cardboard bottom, the whole being covered with cheese-cloth as before.

Experiments 9 to 13 were conducted in a photographer's dark room about five feet five inches by four feet eleven and one-half inches and eleven feet high, the necessary heat being secured from a gas heater and a gas plate. The insects were placed in cardboard cylinders with netting at each end, or in a lantern globe similarly inclosed. One was put upon the floor, a second on a shelf about four feet high and just inside of a window, so that developments could be watched, while the third was placed upon a higher shelf some six feet from the floor. The observations in experiments 10 to 13 inclusive, tabulated below, relate to the insects on the shelf, since they were the only ones that could be watched. Owing to the small dimensions of the dark room and the rather wide shelves, it was found that there was a considerable difference between the temperature at the floor and five feet above. In experiment 13, for example, a temperature of over 125° was maintained five feet from the floor for more than five hours, while a maximum thermometer located on the floor registered but 112°.

Observation, whether the insects were in vials, fruit jars or the relatively much larger dark room, showed that the cockroaches became uneasy when the temperature reached about 112° to 114°F; they exhibited evident signs of distress at 116° or thereabouts and succumbed at a temperature of about 120°. This is a comparatively moderate heat and it would seem entirely practical, in the case of hotel kitchens and similar places where there must of necessity be a good sized heating plant, to destroy the pests with this rather moderate temperature. In practice it would be unsafe to plan for less than thirty minutes at a temperature of 120° if one would obtain satisfactory results. It might be necessary to prolong this period even more in apartments where the insects could retreat in cracks or take refuge under bagging or similar material which would afford some shelter from the heat. It is perhaps unnecessary to add *that* the filling of all cracks and crevices would immensely

facilitate the control of this and other household pests, whether we resort to heat or some other method for the destruction of the insects. Heat is also applicable, though the duration of the treatment would probably have to be greatly extended, for the destruction of wood and bark borers in specially selected material, such as that used in the manufacture of souvenirs. It may also prove of value in destroying young larvae in manufactured articles prior to storage and thus greatly reduce the loss on such materials subject to insect attack.

Experiments with heat

TEMP.	RANGE OF TEMPERATURE AND BEHAVIOR OF INSECTS										DURATION OF HEAT					EFFECTS NEXT MORNING
	100°		110°		115°		120°		125°		100°	110°	115°	120°	125°	
	Time	Behav.	Time	Behav.	Time	Behav.	Time	Behav.	Time	Behav.						
Exp. 1			1.35	a.	1.51 2.35	q. u. m.	2.40 2.43	u. u. m.	3.11 3.35	q. d.		1 h. 41 m.	1 hr. 25 m.	33 m.	1 m.	Dead
Exp. 1a					1.55	u.	2.43	u. m.	3.11 3.55	q. d.			2 hr.	1 hr. 12 m.	44 m.	Dead
Exp. 2							9.55 10.17	s. m. q.	10.38	d.				43 m.	1 m.	Dead
Exp. 2a					10.47 11.25	sink. d.	10.35		10.38 10.40	q. s. m.			50 m.	12 m.	5 m.	Dead
Exp. 3			9.50 9.55 4.50	s. m.	3.15	a.						7 hr.	1 m.			Alive
Exp. 4	10		10.05	burned frantic	10.12	d.					12 m.	10 m.	2 m.			Note rapid rise in temperature Dead
Exp. 5					10.45		10.53		2.09 2.10	down			3 hr. 25 m.	3 hr. 17 m.	1 m.	Dead
Exp. 6					3.25		3.45 4.03	d.					38 m.	18 m.		Dead
Exp. 7					10.14	s. m.	9.58 10.39 10.50	f. m.					52 m.	20 m.		Dead
Exp. 8							11.45 12.45 1.03	no m. d.						1 hr. 20 m.	6 m.	Dead
Exp. 9	2.45	u.	3 p. m.	u.	4.15 4.45	w. m. f. m.					2 hr.	1 hr. 45 m.	35 m.			Dead
Exp. 10	2.53	u.	3.15	u.	4 4.45	a.					1 hr. 52 m.	1 hr. 30 m.	45 m.			Alive[1]

Exp. 11	9.50	u.	10.20	u.	10.40		12.10 12.35	d.			2 hr. 45 m.	2 hr. 15 m.	1 hr. 55 m.	25 m.		Dead [1]
Exp. 12	9.45	u.	10.05	u.	10.30		10.55 11.35	d.	11.40 12.30		2 hr. 45 m.	2 hr. 25 m.	2 hr.	1 hr.35m.	50 m.	Dead [1]
Exp. 13	10.40	u.	10.55	u.	11.15 11.33	u. m.	11.55		12.55 1 4 p. m.	d.	5 hr. 15 m.	5 hr.	4 hr. 20 m.	4 hr. 5 m.	3 hr. 5 m.	Dead [1]

u.= uneasy; m.= movements; f.= feeble; q.= quiet; d.= dead; a.= active; s.= slight.
[1] In 10, 11, 12, 13, the observations refer to those roaches placed above the floor.

NOTES FOR THE YEAR

The following are brief accounts of some of the more injurious or interesting species which have been brought to our attention during the past year.

The false cottony maple scale (Phenacoccus acericola King) and the cottony maple scale (Pulvinaria vitis Linn.) have occasioned numerous inquiries, especially in the southern portion of the State. Both of these species have been repeatedly noticed in the publications of this office, and in this connection we would call attention to the report appearing on another page, upon conditions obtaining in Mount Vernon last summer, and emphasize the desirability of employing the safer whale oil soap solution in efforts to control these pests. Canker worm injury continues in southeastern Westchester county, as reported by Henry Bird and several other correspondents. This species is easily controlled and serious effects resulting from its activities must be charged to either indifference or ignorance.

The European Phytonomus meles Gyll., kindly determined by Prof. E. G. Titus, was reared June 21, 1908 from clover heads collected in the vicinity of Albany. The record shows the establishment in the State of an European species closely related to the introduced and very destructive alfalfa weevil, Phytonomus posticus Gyll., and is therefore of more than usual interest. Trichius affinis Gory was reared from decaying black cherry.

FRUIT TREE INSECTS

Hoplia trifasciata Say. Mr Roy C. Draper states, under date of May 14, 1911, that this beetle was abundant on the blossoms of a small pear orchard in Greece. He adds that the trees were covered with the insects which were gnawing out the sides of the fruit buds. He estimated that at least one-third of the buds were thus affected. Similar injury has been recorded by Messrs Webster and Mally in Bulletin 17, n.s., United States Department of Agriculture, Division of Entomology, page 98. Such depredations are unusual and generally limited in extent. Prompt spraying with arsenate of lead, using six to ten pounds to fifty gallons of water, would probably be the most practical method of checking this insect. Hand picking, in the case of small or low trees, might be equally or even more effective.

Say's blister beetle (Pomphopoea sayi Lec.). This large, usually rare blister beetle is nearly an inch long and is easily distinguished from allied forms by its rather stout, olive green body and the shining black, orange banded legs. It was exceptionally abundant this year, having been reported as feeding upon locust blossoms at Castleton, Slingerlands, Fonda and Hartford by Messrs Matthew Hart, R. S. Nards, Frank Jansen and Smith Bowen, respectively, the dates varying from May 30th to June 14th. Mr Arthur Ward of Philmont reported this beetle as destroying cherry blossoms June 21st. The abundance of this blister beetle was also noted at Cambridge and Schuylerville by Messrs J. G. Ward and A. C. DeGarmo, respectively, though no record was given as to the food habits. It is possible that a portion of these reports was stimulated by the desire to locate colonies of the periodical Cicada, though this could hardly be the entire explanation.

This insect was reported in 1909 as swarming upon roses and other plants, devouring much foliage and causing considerable injury in Voorheesville, Albany county, and Quaker Street, Schenectady county, while in 1900 it was rather abundant and injurious to peach trees at Clarksville. The late Doctor Lintner records this species as feeding upon wheat, the leaves of butternut and on locust blossoms, and states that ordinarily it is rare, only individual specimens being taken. These outbreaks last but a week, and as the grubs feed upon grasshopper eggs the species is beneficial on the whole, even though occasionally committing local depredations. It is possible that the insects could be driven from valued fruit trees by the use of long switches or jarring, or even the employment, when weather conditions are favorable, of a dense smoke. It is better to attempt some such method than to kill the beetles by hand picking or by the use of poisons. The latter can not be used with safety upon trees in bloom, to say nothing of its being against the law.

Red-humped apple caterpillar. (Schizura coninna Abb. & Sm.). This is one of our most striking caterpillars on account of its coral red head, the prominent hump of the same color on the first abdominal segment, and a similar swollen area near the posterior extremity. The full-grown caterpillar is about one and one-quarter inches long, black, with a series of rather conspicuous yellowish dorsal and sublateral lines with white between. There are prominent black tubercles on the body, which

are especially well developed on the thoracic and first abdominal segments, on which latter they form conspicuous conical processes on the top of the swollen red portion. This stage is so peculiar that it is easily recognized. The young caterpillar presents an approach to these conditions, as will be seen from the following description:

Length 6 mm. Head shining jet black, bilobed, with a pair of submedian setose tubercles. Body mostly yellowish orange, mottled obscurely with reddish and with narrow sublateral and lateral yellowish lines. Dorsally there are submedian rows of rather large, black, setose tubercles, those on the thoracic segments and on the 1st, 8th, 9th and 10th abdominal segment, especially the latter, being markedly larger. These abdominal segments show a slight enlargement. There are also sublateral, lateral and suprastigmatal lines of smaller, black, setose tubercles. The true legs are black, while the prolegs are yellowish, the apexes laterally being dark brown or black.

The parent moth is rather inconspicuous with dark brown fore wings, grayish on the outer margin, a dot near the middle, a spot near each angle and several longitudinal streaks along the hind margin, all dark brown. The female deposits her eggs in clusters on the under side of the leaves during the month of July. They hatch soon and the young caterpillars at first consume only the under surface of the leaf, leaving the upper unbroken, though as they increase in size the entire leaf is devoured. The caterpillars are social in habit, remaining in rather compact groups when not feeding and attain maturity in this latitude during August or early September. This gregarious habit frequently results in one or more branches being entirely stripped. There is but one brood in the North though in the South there are said to be two generations. This pest is seldom abundant, and while displaying a marked preference for apple, also occurs on plum, cherry, rose, thorn and pear. It is easily controlled by thoroughly spraying with an arsenical poison, preferably arsenate of lead (15 per cent arsenic oxid) used at the rate of about two pounds to fifty gallons of water.

Numerous specimens of the small, grayish Tachinid, Actia pilipennis Fallen, were reared in early August from the red-humped larvae of this common pest received from Amenia, N. Y. Nothing seems to have been published earlier respecting the food habits of this parasite in America, though it has been recorded from the White Mountains, N. H., New Jersey, District of Columbia and southern Illinois. It was first studied in America by

Professor Townsend who redescribed it under the name of Thryptocera americana.

Forest tent caterpillar (Malacosoma disstria Hübn.). This pest was exceedingly abundant and destructive about a decade ago, defoliating considerable areas of hard maples and stripping many apple trees. Apparently this species is becoming numerous again, since it was reported as stripping woodlands by Townsend Cox, Setauket, and as present in some numbers on the estate of Warren Delano, Annandale, a number of trees being defoliated. Mr Bronk VanSlyke of Ravena found small numbers of the caterpillars in his orchard, while Dr C. S. Merrill of Albany brought in a number from Warrensburg and stated that the pests were on everything in the village. Dr W. E. Britton of New Haven, Conn., found evidence showing that the caterpillar had been abundant at Jay, Essex county, cocoons being present in July on the trunk of nearly every tree, including pines, and on fences and stone walls. On the under side of large branches of apple trees one could see patches five or six inches in diameter, of the cast skins or exuviae of the caterpillars.

This scattering appearance in widely separated localities may be the forerunner of a great abundance of this pest in the next two or three years. It is certainly advisable to watch for their appearance and if they become numerous upon orchard or valued shade trees, resort promptly to remedial measures, such as thorough and early spraying with an arsenical poison, preferably arsenate of lead.

A peculiar apple miner. In connection with our studies of the codling moth discussed earlier, we found an exceptionally fine example (plate 8, figure 4) of the work of a miner operating just under the skin of the apple. This insect appears to work in a similar manner under the bark of apple twigs, making a long, narrow, serpentine mine. The miner is never abundant and the adult has not been reared, though from the character of its work the insect has been tentatively referred to the genus Mamara. Doctor Howard[1] published a brief notice accompanied by an illustration of the work of this insect in Delaware, while ten years later, Mr A. L. Quaintance[2] recorded this species from the Ozark mountains

[1] 1898, U. S. Department of Agriculture, Division of Entomology, Bul. 10, n. s., p. 87–88

[2] 1908, Entomological Society of Washington Proceedings 10:2

and also in Massachusetts. Prof. H. T. Fernald, in a recent letter informs us that repeated attempts to rear the adult have been unsuccessful.

San José scale (Aspidiotus perniciosus Comst.). There have been some complaints the past season to the effect that the scale has multiplied to an unusual extent, especially late in the summer and during the fall, even in orchards where there has been more or less thorough spraying. Investigation of several such cases disclosed the fact that this abundance of the scale was most marked on trees in localities where the treatment was not thorough for some reason or other. Examinations in several orchards where the scale has been prevalent for years, showed exceedingly gratifying conditions so far as checking this pest was concerned.

The concentrated lime-sulfur washes, commercial or home-made, are being used very largely to the exclusion of the earlier preparations. There has been a slight tendency on the part of some to blame the newer washes for unsatisfactory results here and there, though we have been unable to obtain any reliable data in support of any such contention. Results where thorough work was possible have almost invariably been good or even excellent. The manufacture of the home-made concentrated wash has been rendered easier during the last year or two, and in a few instances most excellent results have been secured by cooperation in the making of this preparation. This is usually possible in a neighborhood where there is considerable demand for a lime-sulfur wash, since there is almost invariably a steam plant of some kind which can be readily adapted for this purpose. The invariable result, if the work is properly systematized, is a good product and a marked saving to the community. One great advantage of this wash is that it can be made up in advance if this seems advisable and the necessary storage capacity is available, or it can be prepared just before using, provided the plant has sufficient capacity to meet the local needs.

SMALL FRUIT INSECTS

Raspberry Byturus (Byturus unicolor Say). The small, yellowish brown beetles referable to this species were rather abundant May 17, 1911 in the raspberry patch of Mr S. R. Taber, Milton, N. Y. They were particularly numerous upon the lower leaves and displayed a marked preference for the

unfolding leaf or the unopened bud, eating a circular hole into the latter, the beetles evidently feeding to a considerable extent upon the more tender opening leaves, gnawing between the veins, and as the foliage expands they produce a series of irregular, somewhat linear, skeletonized areas sometimes extending through or breaking through to the under surface of the leaf. In an adjacent patch there were as many as eight or ten of these insects upon individual hills and, in some instances, a number of buds had already been destroyed. Beetles were observed in copulation, This insect was also reported by Mr J. S. Carpenter of Marlboro as being very abundant and injurious to his raspberry bushes.

The pale yellowish brown beetles appear in early May and feed upon the tender leaves and buds. In the case of bad infestations most of the tender leaves may be partly or almost entirely skeletonized. The larvae feed in the fleshy head of the fruit. The most satisfactory method of controlling this species is early and heavy applications of arsenate of lead, preferably just before the beetles appear. In the case of bad infestations it may be advisable to supplement this poison application by spraying with kerosene emulsion, designed to kill the beetles by contact.

Garden flea (Smynthurus arvalis Fitch). An examination May 17, 1911 in the raspberry patch of Mr S. R. Taber, Milton, N. Y., showed that the supposed red spider was this species, a comparatively innocuous form having no connection with the abundance of red spider last season. These small, yellowish garden fleas were rather numerous upon some hills, two and three being frequently seen upon a leaf and, in some instances, five or six were readily found upon one leaflet. This latter, however, was exceptional. The garden fleas did not appear to be inflicting any material injury, possibly causing a very slight rasping here and there upon the surface of the foliage. There was so little damage caused by this species that remedial measures were not considered necessary.

Four-lined leaf bug (Poecilocapsus lineatus Fabr.). Currant shoots showing serious injury (plate 26) by this pest were submitted for examination in early June by Hon. Albert Yeomans, Walworth, accompanied by the statement that this insect had inflicted serious damage upon an extended planting of currants. This pest belongs to the family of true bugs or Hemiptera, is a rather common general feeder and occasionally

becomes excessively abundant, as was the case about 1892 at Ithaca, N. Y. The parent insect is angular in shape, nearly three-eighths of an inch long, black, with conspicuous yellowish green or yellowish longitudinal stripes. It is extremely rapid in motion, secretive in habit and is rarely observed. The young or nymphs are vermilion red and, like the adult, seek shelter. The most characteristic and usually the only apparent evidences are the oval, brown spots on the developing leaves. These are caused by the bugs sucking the green, succulent matter from the interior of the leaf, the affected areas soon collapsing, turning brown and dying. These spots measure about a tenth of an inch in diameter and may be exceedingly numerous. Occasionally the injury is so serious as to result in the wilting and death of many of the leaves.

The eggs of this plant bug, deposited during late June and early July in slits in the shoots, hatch early the following May and the young attain full growth about the second week in June. The adults are so agile and resistant to insecticides that it is practically impossible to destroy them. Watching for early signs of the young or nymphs, indicated by the occurrence of discolored spots described above, and then promptly spraying with a kerosene emulsion, the standard formula diluted with about five parts of water, is the most promising method of checking this insect. The treatment should be exceedingly thorough and the apparatus adapted to underspraying in order to catch as many of the pests as possible. Ordinarily, remedial measures are not necessary.

SHADE TREE PESTS

Spiny elm caterpillar (Euvanessa antiopa Linn.). The large, spiny, black, red-spotted caterpillars of this butterfly feed in colonies, usually near the tips of limbs, and frequently defoliate branches and occasionally considerable portions of trees. This insect was exceptionally abundant in New York State, causing complaints from Long Island, throughout the Hudson valley and from some other sections. The caterpillars were quite numerous and injurious to Carolina poplars and willows in particular, at East Hampton. Specimens of this pest were received from Belleport, L. I., Amenia, Hillsdale, Greenwich, Ballston Spa, Gloversville, Chestertown, Ticonderoga, Elmira, and Oneonta, accompanied by reports of more

or less serious injury. This insect has also been reported as being abundant upon the elms of Binghamton and of Dunkirk. Local observations at New Baltimore, Ravena and the vicinity of Albany disclosed more or less injury by this caterpillar, though most of it was restricted to branches or portions of trees.

The gregarious habits of the caterpillar make its feeding conspicuous and therefore facilitate its early detection. It is comparatively easy to check these leaf feeders by the judicious application of an arsenical poison, preferably arsenate of lead, it being feasible to restrict the treatment to the infested limbs and those adjacent. Limbs bearing clusters of caterpillars can also be cut off and the pests crushed. Ordinarily, remedial measures are not necessary.

Elm leaf beetle (Galerucella luteola Müll.). Injuries by this pest have been exceptionally severe and general on Long Island and in the Hudson valley at least. The damage was so general that the elms of many communities could easily be recognized in midsummer at a distance of several miles because of the contrast presented by the brown, dead foliage.

The elms of Amaganset at the eastern end of Long Island were very severely injured, and the same would have been equally true of East Hampton had it not been for the spraying earlier in the season. Even with this protection there was considerable injury. The brown foliage of elms was a rather common feature of the landscape on both sides of the Hudson river from Yonkers north to Albany. Mr Henry Bird reports the pest abundant at Rye. The injury to more or less isolated trees in woodlands or on the edges of fields and some distance from the highway was very evident during the past season.

Many of the trees in Albany were badly eaten by the elm leaf beetle, this being especially marked on Clinton avenue, Lark and Hamilton streets and those adjacent to the two latter. The elms of Menands and Watervliet were very seriously affected, this being especially true in the southern portion of Watervliet. Almost every tree in this section had the foliage severely injured and in many instances it was completely destroyed. The damage in Watervliet appears to have been more widespread and general than has been the case for the past twelve or fifteen years. Many of the elms of Green Island were severely injured, though the work of the insect was not nearly so general as at Watervliet. The same was true of Cohoes, while Waterford had very many trees which had been seriously

affected. There was also general injury in North Troy or Lansingburg, many of the trees having practically all the foliage destroyed. The elms of Hoosick Falls suffered greatly, and, to a less extent, those of Valley Falls and Johnsonville.

The elms of both Stillwater and Schuylerville were very severely injured, many having the foliage practically destroyed. There was serious and general injury at Ballston Spa and considerable damage at Saratoga Springs in spite of the spraying. The trees of Fort Edward and Hudson Falls were practically defoliated by the insect, especially near the centers where the infestation is of longest standing. A number of the elms in these communities had died and others were in a greatly weakened condition owing to the injuries of successive years. The damage at Glens Falls was evident though not so severe, the difference undoubtedly being due to the spraying of the past season.

An examination of the elms both in the city of Albany and along the Delaware and Hudson railroad shows an interesting condition. The trees on the streets traversed by trolleys are, as a rule, more severely injured by the beetle than those on adjacent thoroughfares. The elm leaf beetle has not obtained a foothold west of Slingerlands on the Susquehanna division of the Delaware and Hudson railroad. This is a section not traversed by the electric car. A very different condition obtains on the southern portion of the Saratoga and Champlain division of the Delaware and Hudson railroad comprising a section which has for some years had electric car service. Evidences of severe injury are to be noted along most of the route north of Glens Falls, manifest exceptions being Gansevoort, Round Lake and Lake George. The two former are off the line of the electric cars and the latter has probably not had trolley service for a sufficient time to allow general infestation. The elm leaf beetle, as is well known, is very prolific and naturally quite local in its habits. The electric cars, traversing as they do many of the tree-lined streets of various communities, afford abundant opportunities for the collection and dissemination of the beetles. The distribution of the badly infested areas lends weight to the belief that the electric car is an important factor in the dissemination of this pest.

There are numerous other localities not served by the electric lines where injury has been severe, especially in the last few years. Even comparatively isolated groups of elms in front of

a farmhouse may be badly injured. Many of these places are along highways traversed by numerous automobiles, and it seems very probable that the comparatively recent general use of these vehicles has also been of material service in distributing this pest.

The exceptionally dry weather of the last few years has had a serious effect upon many trees and has doubtless accentuated, by reducing the vitality of the trees, the injury inflicted by the elm leaf beetle. It is also possible that climatic conditions have been unusually favorable for the increase of this pest. Nevertheless, present conditions would seem to justify the expectation of more widespread and general injury in the future than has obtained in the past. The experience of communities infested by the elm leaf beetle for a decade or more has shown that unless the trees are adequately protected, many are bound to succumb to attacks by this insect. Thousands of elms have perished during the last twenty years from this cause alone in the cities of Albany and Troy and many more are in a precarious condition owing to lack of adequate protection in recent years, due either to no spraying or indifferent work.

The problem at the present time is to secure the general recognition of the necessity for protecting our elms if the trees are to be kept in even a fairly good condition. Repeated defoliations in the past have resulted in the wholesale destruction of trees, and under the changed conditions of the last decade or thereabouts, even more general injury may be expected in the future. A number of communities in the Hudson valley have been spraying their elms for some years and, in some instances at least, those interested in the work have been inclined to blame the failure to secure good results upon the insect itself, climatic conditions or some other than the true cause. The facts of the case are that thorough spraying with a modern equipment should result in keeping the leaves green, vigorous and practically intact throughout the season, even in localities where the elm leaf beetle is exceedingly abundant and not excepting trees adjacent to those practically skeletonized by the pest. The essentials are timely and thorough sprayings. Examinations of conditions in several communities the past season force us to the conclusion that most of the unsatisfactory results following spraying operations are due to careless or slovenly work. It is impossible to stand at a distance and spray an elm tree in such a way as to secure approximately

fair control. It is a rather common occurrence to find the lower limbs fairly well sprayed, while the upper branches are almost untouched by the poison and, as a consequence, the latter are severely injured by the beetle. Good poison and efficient apparatus can be easily secured and in most instances has been obtained. The weak link in the chain of practice at present is the time and method of application, particularly the latter. Spraying trees is a disagreeable, hazardous occupation and in order to secure the best results, it is necessary to make the compensation such as to result in a keen competition for the position of nozzle man. The application of business principles would justify the placing of this work in the hands of a party who at least understood the rudiments involved (a skilled forester would be even better) and giving him authority to insist upon any reasonable standards in methods and operation. Let this man be held rigidly accountable for unsatisfactory results following spraying operations and we shall see a marked change in the elm leaf beetle situation.

The elm leaf beetle is not such a serious pest in Europe, and it would seem, in view of the probable continuance of the severe injury of the last few years, as though a serious effort might well be made to secure natural enemies, since they appear to be very effective checks upon this beetle in European countries.

Bronze birch borer (Agrilus anxius Gory). Dying or dead white birch trees, especially the ornamental weeping birches on lawns, have been a rather common sight during recent years in cities in the western part of the State. It is now stated that all the birches in Geneva have been killed or practically so, while many of those in Elmira and Ithaca have been destroyed. The writer has noted dying birches in Rochester and several villages in that general section. The past season our attention was called to a group of dying birches at Lansingburg, showing that this insect has commenced its nefarious work in the eastern part of the State. Similar injury or something closely resembling it was observed on the grounds of the Hotel Sagamore, Lake George.

The signs of injury are very characteristic, it requiring but little experience to recognize the work of this pest. Usually the thin foliage and dying condition of the upper branches are the first evidences of trouble. A more careful examination may show well-marked, annular ridges around some of the smaller

branches, accompanied frequently by reddish or rusty brown spots here and there on the white bark, indicating the operations of a borer beneath. This indentification can be confirmed by cutting into the bark, especially where there are ridges, and the disclosing in the inner bark or sapwood of a flattened, usually more or less sinuous channel. Advanced injury is usually characterized by numerous interlacing galleries in the bark of the upper branches, the limbs above being mostly dead. The cause of this trouble is a flattened, whitish, rather delicate grub about three-quarters of an inch long, with a large, flattened anterior extremity and a pair of horny, serrate processes at the opposite end of the body.

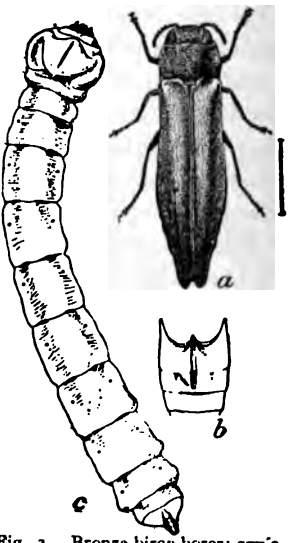

Fig. 3 Bronze birch borer: *a*=female beetle; *b*=first abdominal segments of male from below; *c*=larva from above, all enlarged about 3½ times. (After Chittenden, U. S. Dep't Agric. Div. Ent. Bul. 18, n. s.)

The destructive work of this pest is confined to the inner bark and sapwood, places inaccessible to ordinary applications, consequently spraying or the application of deterrent substances are of little or no value. The grub winters in its burrow, transforming to a pupa in the early part of May, the moderately robust, olive brown beetle from three-tenths to nearly one-half an inch long appearing the latter part of May or early in June. The only satisfactory method of checking this borer is to cut and burn, at some time prior to the appearance of the insect, all infested trees or portions of the same. Limbs that appear but slightly affected are usually doomed, since the galleries generally girdle or nearly girdle the limb and it is only a question of time before the branch must succumb. It is much better to remove such and burn the wood at once, rather than to allow the beetles to escape and attack adjacent trees. It is obvious that the more thorough the work the greater will be the benefits resulting from this treatment. This applies not only to isolated groups but to all the trees in a given section. There should be the fullest possible cooperation in an effort to check this pernicious enemy.

White marked tussock moth (Hemerocampa leucostigma Sm. & Abb.). This well known city pest has

been rather abundant in Albany, defoliating or nearly stripping many of the horsechestnuts and lindens (plate 25), though the elms and maples do not appear to have been seriously affected. The work of this caterpillar was also observed on horsechestnuts in particular, though to some extent on lindens at Menands, Watervliet, Green Island and Cohoes.

It is comparatively easy to remove from infested trees during the winter, the conspicuous snow-white egg masses (plate 27, figure 2) attached to filmy cocoons. This is very effective, since the female moth is wingless and rarely does more than crawl onto the surface of the cocoon prior to laying her eggs. The crawling powers of the caterpillar are also very limited; consequently this insect is an extremely local pest. It is also amenable to thorough and timely sprayings with a poison, preferably arsenate of lead (15 per cent arsenic oxid) using about two pounds to fifty gallons of water and making the application when the caterpillars are small and therefore most susceptible to any such poison.

European elm case bearer (Coleophora limosipennella Dup.). This introduced species has been known for some years in the vicinity of New York City and on Long Island. The curious brown, somewhat flattened cases of the larva are quite characteristic and are sometimes accompanied by rather serious injury. It was surprising last June to discover the larvae and work of this insect in a somewhat out of the way location near the Connecticut line in South Salem, some forty miles from New York.

FOREST PESTS

Hickory bark borer (Eccoptogaster quadrispinosus Say). The pernicious activity of the hickory bark borer has been most evident in the eastern part of New York State, particularly in the immediate vicinity of New York City during the last three years. An examination of the hickories in Prospect Park, Brooklyn, in 1909 showed that a large number of the magnificent trees in that extensive park were so seriously affected that it would be necessary to cut out many in order to save the remainder. Last year there were complaints of injuries in the region of the Bronx, while the destructive work of this borer has been continued during the past season. Its nefarious operations were reported by Mr Henry Bird of Rye.

Diseased or dying hickories are to be found in many places in the Hudson valley. A personal investigation of conditions in the vicinity of Tivoli showed that a number of trees had been killed by this borer during the past two or three years, and that many, possibly the majority, in that section were so seriously infested that it was only a question of a few months before they must also succumb to the attack. The severe droughts of the last two or three years have undoubtedly been favorable to the development of this pest, since the vitality of many trees has been lowered and they have thus been rendered

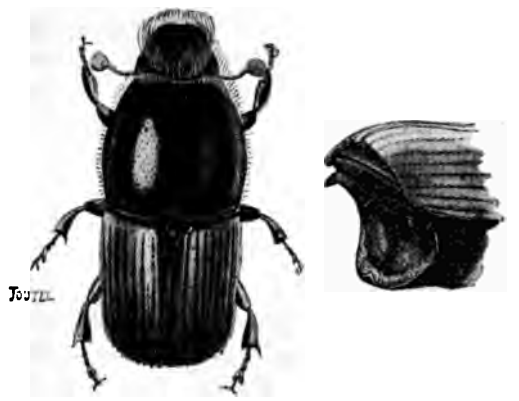

Fig. 4 Hickory bark borer from above and side view of the posterior extremity of the male (author's illustration)

more susceptible to attack by insect enemies. It is also possible that the extremely cold weather of several years ago had a deleterious effect upon the trees. The insect is now so abundant in many sections that unless radical measures are adopted, many trees will be destroyed another year.

The preliminary signs of injury, such as wilting leaves and dead twigs in midsummer, are exceedingly important because they indicate serious trouble before it has passed the remedial stage. Examination of injured trees in the fall or during the winter may show particles of brown or white sawdust in the crevices of the bark, and in the case of some trees a few to many circular holes appearing as though they had been made by number eight buckshot. The recognition of this sawdust is quite important, since the dark brown or black, rather stout, cylindrical parent beetle about one-fifth of an inch long inva-

riably starts its gallery under a protecting scale of bark, the sawdust mentioned above being the only external evidence. Such trees are more dangerous to the welfare of adjacent living hickories than others which may be fairly peppered by the numerous exit holes. The external evidences cited above should be supplemented by cutting down to the sapwood. The exposure there of longitudinal galleries one to one and one-half inches long, about one-eighth of an inch in diameter and with numerous fine, transverse galleries arising therefrom and gradually spreading out somewhat fan shaped, is conclusive evidence as to the identity of this pest. In very early stages of the attack the longitudinal gallery described above, with a series of minute notches for the reception of eggs on either side, may be all that can be found. Only a little experience is necessary before one can recognize the characteristic galleries of this borer. These are almost invariably to be found somewhere upon infested trees, since an attack is rarely discovered before at least some of the grubs have commenced working across the bast fibers.

The insect passes the winter in oval cells as stout, whitish, brown-headed grubs about one-quarter of an inch long, the beetles appearing in the latitude of New York from the last of June to the last of July. There is only one generation in this section of the country. This greatly facilitates the control of the pest, since it is not necessary to guard against a midsummer infestation.

There is only one thing to do in the case of a serious infestation such as that indicated by dying trees or branches. All badly infested trees or portions of trees should be cut and at least the bark burned before the following June, in order to prevent the grubs then in the bark from maturing and changing to beetles which might another season continue the work in previously uninfested trees. It is particularly important to locate the hickories which have died wholly or in part the past summer, because they contain living grubs. General cooperation over an extended area in the cutting out of infested trees and burning of the bark as indicated above, will do much to check this deadly enemy of hickories. This destruction of the insects does not prevent the utilization of the wood and timber commercially, provided the bark is destroyed within the time limits given above. Slabs from saw logs and fire wood with the bark on should all be burned during the winter.

This also applies to trimmings and small limbs which have no commercial value. If it is impractical to work up logs and burn the slab wood, the insects can be destroyed by a prolonged submergence in water or by removing only the bark and burning that.

Two-lined chestnut borer (Agrilus bilineatus Weber). An investigation of conditions on the estate of Mr Norman de R. Whitehouse at Old Westbury, N. Y., showed that there were probably some two hundred red oaks which had been killed by this pest. Most of the affected trees were small with a trunk diameter of less than six inches and were usually well shaded and therefore presumably less vigorous.

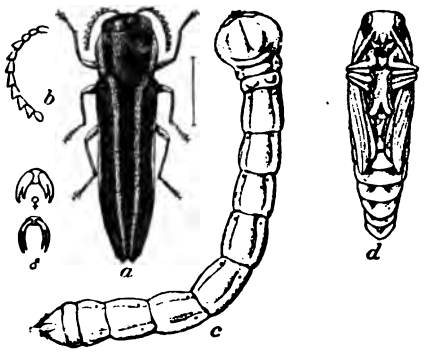

Fig. 5 Two-lined chestnut borer: *a*=adult beetle, enlarged; *b*=antenna of same, enlarged ♀=claws of posterior tarsi of female, somewhat enlarged; ♂=same of male, somewhat enlarged; *c*=larva, enlarged ; *d*=pupa, enlarg d. (After Chittenden, U. S. Dep't Agric. Div. Ent. Cir. 24, 2 ser. '97)

A few of the rather scarce, larger trees were also affected. One group consisted of three with diameters of about fifteen, twelve and nine inches, respectively. They had died during the summer, probably in late August or early September, and were standing near a tree about nine inches in diameter which had evidently been killed the preceding season. This is an instance of the beetle being somewhat local in habit and conditions comparable to those frequently noted in the case of the allied bronze birch borer, Agrilus anxius Gory, another pernicious enemy of trees. The galleries of this chestnut and oak pest were rather common in oak stumps at Nassau in a wood lot where limited annual cutting was the prac-

tice though there was no evidence here of serious injury to living trees. Injury was also reported from Garden City.

The work of this insect is easily recognized by the irregular, anastomosing galleries traversing the inner bark and frequently girdling the tree. Many of these galleries are only about one-sixteenth of an inch in diameter, though the mature grubs cut a channel nearly a quarter of an inch wide. The beetle is nearly three-eighths of an inch long, black, and with the wing covers marked with two golden yellow stripes as illustrated in the figure. The borer or larva is long, slender, flattened, the part just behind the head considerably swollen, and a milk white or yellowish color except the mouth parts and the peculiar minutely serrate anal processes, which are dark brown. This borer winters in its gallery, usually with the slender body abruptly bent near the middle. The pupa is white like the larva.

This borer is a well-known enemy of chestnut and oak, there being several records of serious injury in various parts of the country. It would not be surprising if this outbreak was an indirect result of the chestnut blight. Most of the chestnuts near Old Westbury, L. I. have been killed by the disease, though there are still hundreds dead or dying and therefore presenting favorable conditions for borer infestation. Beetles issuing from the chestnut, in the absence of this food plant, must necessarily concentrate their attack upon adjacent oaks or perish. Since these borers winter in the affected trees, the cutting out and removal or burning of the wood before growth begins in the spring will do much to check the trouble and thus destroy many borers which normally would mature and attack other trees the following season.

MISCELLANEOUS

Abia inflata Nort. The false caterpillars of this species were transmitted by Leonard Barron from Garden City, N. Y., under date of June 8, 1911 accompanied by the statement that they were destroying Lonicera in that section.

Larva. Length when extended 2.2 cm. Head brownish, the ventral third fuscous whitish. Body mostly yellowish and sooty yellowish. There is down the middle of the back a broad, variably yellowish stripe broken by a series of median, quadrate or rectangular spots as follows: on the annulets of the anterior portion of each segment two transverse, irregularly quadrate

spots and on the broader posterior annulet a distinctly larger, quadrate or irregularly quadrate, black spot. The color of this posterior annulet is a deep orange and gives the impression of a partially transverse band bounded sublaterally with an irregular, rather large, black spot. Sublaterally there is a broad, fuscous yellow stripe and laterally a yellowish white stripe, the boundary between the two being marked by an irregular line of black spots arranged much as those on the dorsum. Venter, true legs and prolegs (the latter, sixteen in number, being located on the second to the ninth and fourteenth segments, respectively) whitish. At the base of each proleg there is a short, oblique stripe of yellowish.

June beetles. Last spring, May or June beetles were exceptionally abundant here and there in the Hudson valley, attracting notice by invading lighted dwellings and feeding upon various forest trees, especially oak and chestnut. In the vicinity of Albany were taken several species, namely Lachnosterna grandis Sm., L. fusca Froh., L. hirticula Knoch, L. hirsuta Knoch, while the usually rare Polyphylla variolosa Hentz, was very common at Schenectady in early July, though no damage was observed, according to Richard Lohrmann. The above list of species should not be considered as exhaustive, since it includes only those forms taken in connection with other collecting.

The young or larvae of the May or June beetles are the well-known white grubs of our grasslands, which are sometimes rather injurious to strawberries, potatoes and some other crops planted upon sodland badly infested by these pests. Occasionally the grubs become so numerous in old seedings as to eat off practically all the roots and make it comparatively easy to roll up the sod with a potato hook or similar implement. The life history of the species may be summarized as follows: The eggs are laid by the parent beetles in loose soil and hatch about a month later; the grubs slowly increase in size for at least two years, and from the middle of June till the middle of September of the second or third year, construct earthen cells in which the transformation to the pupa occurs and from which the beetles emerge the following spring. Fall plowing is frequently advised since the breaking up of the earthen cells containing the soft, white pupae is invariably followed by the death of the insect. Injuries to crops can be avoided in large measure by refraining from planting those susceptible to attack upon badly infested sodland. A well-planned rotation

of crops is one of the most efficient methods of preventing the undue multiplication of these insects.

Cecropia moth. This large insect, Samia cecropia Linn., as is well known, is subject to attack by a number of parasites, one of the most efficient of these being Frontina frenchii Will. The puparia of this fly are sometimes very numerous in the cocoon of the host (plate 27, figure 3) which in the case illustrated contained forty-one puparia.

Cotton moth (Alabama argillacea Hübn.). The unusual flights of this species attracted the notice of several entomologists. Prof. C. R. Crosby of Cornell called our attention to the presence of the moths at Ithaca. Writing under date of September 28th, he states that the insects covered the ground beneath the street lights, by the thousands. They were numerous at Schenectady, " masses sometimes covering whole sides of buildings near electric lights," according to Richard Lohrmann. Mr Henry Bird of Rye also reported the appearance of the moths and recorded a marked preference by them for the thin-skinned Concord grape as compared with the thicker skinned Salem, hundreds being observed feeding upon the fruit. He states that the punctures made by the moths were exceedingly minute and left no immediate trace, though it is probable that the keeping qualities may be affected. A great abundance of this insect was noted September 23d in Philadelphia by Dr Henry Skinner, while Doctor Britton, state entomologist of Connecticut, records the presence of hundreds at New Haven, Conn., September 25th. Prof. H. T. Fernald reports the capture of a number of moths the last week in September at Amherst, Mass., and Arthur Gibson records their presence at St Thomas and Sarnia, Ontario. These appearances are interesting, as they probably indicate extended flights. These insects are no menace to residents of the North, since they appear unable to live upon any other than the cotton plant.

Depressaria atomella Hübn. Larvae of this species were transmitted by Mr John Dunbar of Rochester, under date of March 25, 1911, accompanied by the statement that they devoured the blossoms of Cytisus albus. The infested plants were obtained by him from another florist in the city, who in turn had imported them from Holland the preceding fall. Adults were reared April 20th and were apparently the above-named southern and central Europe form, though the

specimens were so rubbed that a positive identification was impossible. A description of the larva is given below.

Larva. Length 1.5 cm. Head yellowish brown, the most of the labrum, the sutures of the clypeus and the posterior lateral portion of the sides of the head fuscous or dull black; labial palpi tapering, light brown, the sutures transparent; maxillary palpi with the basal segment whitish transparent, the distal segment cylindric, with a length one-half greater than its diameter, fuscous. Thoracic shield brownish yellow, laterally dark brown or black, these markings being produced on the posterior margin nearly to the median line where they are bidentate and also forming an indistinct, broad tooth near the base of this mesal projection. Body: General color yellowish brown with rather broad, submedian, fuscous yellowish stripes, the latter dotted with dark brown, submedian tubercles; sublaterally there is a dark brown stripe; laterally and ventrally the color is fuscous yellowish; anal plate fuscous yellowish; true legs shining black or piceous; prolegs dark brown, except the posterior which are fuscous yellowish; thoracic segments with a submedian small, and a little more laterally, a larger, dark tubercle; sublaterally there is a larger, compound tubercle and laterally a smaller tubercle on the anterior and posterior annulae; abdominal segments with submedian tubercles on the anterior and posterior annulae, those of the latter slightly more lateral, the anterior annula also with a rather large lateral tubercle, all of these unisetose.

Gracilaria. A number of azaleas injured by a leaf feeder were brought to our attention the past winter. Some of these were collected by Mr T. F. Niles in a greenhouse at Yonkers, the azaleas having been imported. Similar trouble was also called to our attention by Mr John Dunbar of Rochester.

An examination of the leaves shows that the caterpillars usually turn over the tip, webbing it down with fine, silken strands, and eating away the tissues of the infolded undersurface. The injured portion turns dry and the retreat contains numerous small, black particles of frass. The whitish, silken cocoons may frequently be found on the leaves close to the affected area, though an occasional one is spun under a marginal roll. One moth was reared and through the courtesy of Dr L. O. Howard of the Bureau of Entomology, determined as a species of Gracilaria near violacella by Mr August Busck. The immature stages are described below.

Larva. Length 7 mm. Head greenish yellow, the labrum and mouth parts light brown, the body mostly pale green, the posterior margins of the segments lighter, the three posterior segments yellowish tinted. Fine, almost invisible hairs origin-

ate from minute tubercles; venter mostly yellowish; true legs whitish transparent; prolegs yellowish green; abdominal segments 1, 2, 6, 7 and 8, apodal.

Pupa. Length 6 mm, slender, yellowish green, the dorsum of the head a brownish shade, that of the abdominal segments brownish, the color being distinctly darker on segments 2 to 6. Antennal cases long, extending beyond the tip of the abdomen, those of the posterior legs to the penultimate segment, those of the yellowish green wing cases to the fifth abdominal segment.

Exuvia. Length 6 mm, slender, whitish, protruding from a cocoon such as that described above. Antennal cases extremely long, slender, multiarticulate; dorsum of the abdomen slightly chitinized and rather thickly set with chitinous dots.

Sooty Crambus (Crambus caliginosellus Clem.). A number of these grass webworm caterpillars were received under date of June 21, 1911 from Mr R. L. Skinner, Greenwich, N. Y., accompanied by samples of the work and a statement to the effect that they had destroyed a field of popcorn. He also adds that he had similar trouble in this field several years before. There was serious and somewhat general injury by grass webworms in 1905, corn planted upon sod or in the vicinity of grass suffering severely and even grassland being badly affected. The full-grown webworm caterpillars appear very much alike, being dull whitish or purplish with a darker head and about three-quarters of an inch in length. The young caterpillar of the sooty Crambus has a pale amber head and is a dirty translucent white with irregular, reddish spots on the middle of the body. Scattered, light colored hairs occur above the head and the body.

The female may deposit as many as one hundred and seventy-five eggs, which are dropped indiscriminately. The partly grown caterpillars winter in the protection of grass stubble, and in plowed grassland commence feeding upon the corn as it appears above the ground. Some stalks may be nearly girdled and the worms are frequently embedded in cavities they excavate. As many as thirty caterpillars have been found in a hill, some stalks of which were entirely destroyed, while in others the plants were small, yellow and sickly.

Injuries to corn and other crops by this insect and its allies must be considered more or less accidental, especially as the depredations are usually more marked on the borders of fields adjacent to grass than elsewhere. An excellent preventive is to keep corn and other crops liable to suffer from these pests as

distant from grasslands as practical and avoid planting upon recently turned sod. Plowing of infested land in late summer or early fall, August or early September, should result in most of the caterpillars perishing before the following spring. This can not always be done, and danger of injury by species of webworms which feed in the early spring may be obviated to some extent by delaying the plowing as late as possible so as to give the caterpillars an opportunity to complete their growth before another crop is planted. Early spring plowing may only aggravate the injury by retarding the development of the caterpillars, with the result that when corn or some other crop appears, it is speedily devoured by hordes of half-starved webworms. Extra heavy seeding is also advantageous under these conditions, since there is a greater liklihood of some stalks escaping injury.

Lunate onion fly. (Eumerus strigatus Fallen). Numerous specimens of this European fly, kindly identified by Mr W. R. Walton through the courtesy of Dr L. O. Howard, were reared August 19, 1911, from Iris roots received from Saratoga Springs, N. Y., which had also been badly injured by the Iris borer, Macronoctua onusta Grote. There appears to be no published record of this insect having been found in America, though Dr F. H. Chittenden kindly informs me in a recent communication, that flies were reared in the Bureau of Entomology from Amaryllis bulbs received from Buffalo, N. Y., in October, 1906, and also from bulbs from Connecticut and Brownsville, Texas. The species is evidently widely distributed. The establishment of this insect in America is of more than passing interest, since it is recorded as attacking onions in Europe. Verrall.[1] states that the maggots sometimes destroy the entire crop quite as the larvae of Merodon affect Narcissi. The larvae occurred in July and pupated in the bulbs or in the neighboring earth. Dr J. Ritzema Bos[2] finds that one to several maggots may occur in the heart of an onion, causing a decay accompanied by a black discoloration. He is of the opinion that there are two generations annually and describes the full-grown maggots as one-third to nearly one-half of an inch long, dirty grayish yellow and granulated in appearance. Francis Walker[3] records this species as generally distributed in Great Britain and adds that the larvae belong-

[1] 1901, British Flies 8.615.
[2] 1891, Tierische Schädl. u. Nützl. p. 634.
[3] 1851, Insecta Britannica, Diptera, 1:241-42.

ing to the genus feed on bulbous roots. Verrall states that it is recorded from all North and Middle Europe and also from Italy. It would seem as though this insect might become a serious enemy of American bulbs, particularly the onion.

This onion fly is noticed most frequently in economic literature under the generic term Eumerus, though the discovery of Meigen's 1800 paper may necessitate the substitution of Zelima for the better known Eumerus. This species has also been redescribed a number of times, the recognized synonyms being Eumerus aeneus Macq., E. funeralis Meign., E. grandicornis Meign., E. lunulatus Meign., E. planifrons Megn., E. selene Lw. (not Meign.) beside another probable synonym, Syrphus acanthodes Rossi and two varieties. In view of the possible economic importance of this insect a description of the adult and an illustration of the wing are given below.

Adult. Length 6 to 7 mm, head rather small, slightly swollen, hemispheric; eyes in the male narrowly contiguous. Face in the male grayish black, with a sparse, yellowish pile, in the female dark grayish with scattering, short setae. Antennae dark brown in the male with grayish reflections, black in the female, the inner face hoary; the two basal segments short, the third narrowly oval, with a length nearly twice that of the two preceding. Frontal triangle of the male with golden yellow setae; vertex bluish in the

Fig. 6 Wing of lunate onion fly, *Eumerus strigatus*, enlarged (original).

male, aeneous in the female and with a thick pile which is black on the vertical triangle and otherwhere mostly tawny. Disk of thorax and scutellum aeneous, the former with submedian, hoary, evanescent stripes and short, coarse setae. Abdomen bronzy black with three lateral oblique, white, lunate bands, the posterior pair in the male largely obscured by coarse, yellowish setae, the latter also thick on the apex of the abdomen. Wings grayish, the stigma tawny. Halteres yellowish white. Legs mostly black, the tip of the coxae, femora, the basal third and the apex of tibiae, and the three basal tarsal segments yellowish or tawny red; the femora has about twelve short, stout spines on the distal half of its ventral margin.

Xylophagus lugens Loew. The large, carnivorous larvae of this species, easily recognized by the elongate, heavily chitinized conical head, were found at Nassau, N. Y., in decaying chestnut bark from which Winnertzia pectinata Felt was subsequently reared. Two sizes of larvae were observed but they all produced adults within a short time and probably represent variations in nourishment or possibly sexual differences. The larva presents a close general resemblance to that of the allied Xylophagus abdominalis Lw. occurring in decaying pine bark, except that in the latter the three segments behind the head are each well chitinized dorsally.

Larva. Lengtl. about 2.5 cm, whitish or dirty white, the head slender, conical, heavily chitinized and with a length greater than the body diameter (plate 27, figure 4). The segment behind the head is well chitinized dorsally, except for two narrow, irregular sublateral lines. The next following has a pair of irregularly subquadrate submedian chitinous plates. The incisures dorsally and ventrally are marked by slight, median thickenings, pseudopodous in character and bordered by a narrow line, in places doubled, of chitinous points. Near the middle of each body segment there is laterally a sparse group of four or five rather long, fulvous hairs. Anal plate chitinized, produced as a pair of submedian stout processes, each ornamented with several long, fulvous hairs. The submedian anal spiracles are located on this plate and are distinctly darker.

Pupa (plate 27, figure 4). Length 1.5 cm, diameter 3.5 mm; color dark brown anteriorly; including the first three abdominal segments, the posterior segments yellowish brown. The antennal cases are short, diverging, conical, reddish brown structures, with a stout cephalic horn at the external basal angle; dorsum of thorax dark brown. Wing covers and leg cases dark brown. Abdominal segments with a distinct, rugose, darker thickening on the anterior and posterior margins, the latter with moderately stout, rufous bristles laterally; terminal segment about half the length of the preceding, with a median process or knob bearing a pair of stout, conical, diverging processes, the latter apically with a fuscous, chitinous spur.

Psilocephala melampodia Loew. The white Dipterous larva of this species was collected April 8, 1911 under decaying pine bark at Albany, N. Y.

Larva. Length 2.5 cm, diameter 2 mm. Head small, chitinous, light brown, the anterior extremity darker; short, stout antennae appear to be present. There are a few sparse setae on the ventral surface of the head. Posterior margin of head with sublateral fuscous markings which appear to unite in a fuscous

median line extending back apparently to a fuscous ocular spot near the anterior extremity of the second body segment. General coloring of the body yellowish white, the anterior and posterior segments slightly smaller than the median ones.

Pupa. Length 1.5 cm, the thoracic segments somewhat swollen, the abdominal segments of a nearly uniform diameter, each separated by a strong constriction; color a variable yellowish brown and dark brown, the deeper coloring being confined largely to the wing and leg cases and the abdominal incisures. Anterior extremity truncate, the lateral angles bearing the short, subconical antennal cases; thoracic horns short, subconic. Wing cases extending to the middle of the second abdominal segment, the leg cases to the anterior margin of the third abdominal segments. Abdominal segments 9, with a rudimentary 10th, each separated by a deep constriction; near the middle of segments 1–7 a stout conic spine laterally and posteriorly an irregular, sparse band of short, stout setae. Posterior extremity produced, apically with a pair of submedian, long chitinous processes.

The adult was reared May 1, 1911, permitting the identification of the above described early stages.

Blood worms (Chironomus species). A good sized, living blood worm, some 8 mm long and dark red, was brought into the office January 6, 1911 from the Bender Hygienic Laboratory, accompanied by the statement that it was blown from the nose of a lady who had suffered from several attacks of nosebleed, the larva being found upon her handkerchief. The specimen was transmitted to the Bender Laboratory by Dr J. E. Vigent of Red Hook, N. Y. The blood worms are stated by Johannsen to feed upon the small, red worms known as Tubifex or other small creatures presumably containing hemoglobin in the blood. It hardly seems possible that this creature could have been responble for the nosebleed; it may have been taken into the mouth accidentally when drinking and, in a fit of coughing, thrown up into the upper respiratory passages.

Teratology. Deformities of antennae and other appendages are comparatively common among insects, though asymmetrical modifications of the body, aside from those due to hermaphroditism, are comparatively rare. An interesting malformation of the abdomen was detected in the case of a specimen of Winthemia quadripustulata Fabr. (plate 8, figure 3) taken at Poughkeepsie, N. Y., July 17, 1903. It will be noted from an examination of the illustration that the second abdominal segment is wanting on the right side, while on the left it appears to have attained almost a normal development.

Protective mimicry. The posterior extremity of many female Lepidoptera is protected with a thick tuft of scales. This structure is especially well marked in the Sesiidae. Professor Beutenmueller has given illustrations of the tufts in the case of a number of species. This structure is presumably protective and is doubtless of some value in maintaining equilibrium while the insect is in the air. It is not improbable that these scale tufts are intimately connected with a scent gland so that when expanded they are of material service in attracting the opposite sex. We have shown at plate 17, figure 4 the expanded tuft of Pyrausta theseusalis Walk. as it exists upon a museum specimen which evidently died with the tuft fully expanded. Superficially, this expanded tuft resembles some of the downy, floating seeds, such as that of the dandelion. A closer examination shows this circular, apparently homogeneous organ to consist of two closely apposed, semicircular parts each overlapping the other slightly.

Leptosyna quercivora n. nom. This specific designation is proposed for L. quercus Felt 1911, preoccupied by L. quercus Kieff. 1904.

PUBLICATIONS OF THE ENTOMOLOGIST

The following is a list of the principal publications of the Entomologist during the year 1911. Forty-four are given with titles,[1] time of publication and a summary of the contents of each. Volume and page numbers are separated by a colon, the first superior figure gives the column and the second the exact place in the column in ninths: for example, 75:1025[12] means volume 75, page 1025, column 1 in the second ninth; that is, nearly one-fourth of the way down.

Insects in the Grain. Country Gentleman, November 3, 1910, 75:1025[12]

A summary, economic notice of the Angoumois grain moth, Sitotroga cerealella Oliv. and a short biologic account of a mite abundant in chaff. It is probably Tyroglyphus longior Linn.

Codling Moth in the Hudson Valley. Country Gentleman, December 15, 1910, 75:1174[22]

Summary account of work of Carpocapsa pomonella Linn. in 1910, showing that over 90 per cent sound fruit may be obtained with but one spraying, even when there is a small crop and the second brood of the moth is abundant.

The Greenhouse White Fly. Country Gentleman, December 22, 1910, 75:1198[12]

A brief account of Aleyrodes vaporariorum Westw. with special reference to control measures.

Recent Experiments with the Codling Moth. Economic Entomology Journal, 3:474–77

Summary of experimental data obtained in 1910.

Repelling Squash Bugs. Country Gentleman, December 29, 1910, 75:1222[16]

A brief account of the squash bug, Anasa tristis DeG. with a short notice of the striped cucumber beetle, Diabrotica vittata Fabr.

A New Lestodiplosis. Entomological News, January 1911, 22:10–11

A description of Lestodiplosis peruviana reared by C. H. T. Townsend from Hemichionaspis minor Mask.

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[1] Titles are given as published and in some instances they have been changed or supplied by the editors of the various papers.

Do Sprays Poison People? Country Gentleman, February 16 1911, 76:154[11]

A general discussion of the application of poisons to vegetation, th effects thereupon and the possibility of thus poisoning domestic animal and human beings. The need of care in using these materials is emphasized

Miastor and Embryology. Science, 1911, 33:302–3

A summary discussion of the adaptability of Miastor larvae to embryo logical work.

Two New Gall Midges (Dipt.). Entomological News, 1911 22:109–11

Asphondylia vincenti and Hyperdiplosis eupatori described from the island of St Vincent. The former was reared from fruit of Jussiaea linifolia and J. suffruticosa and the latte from a conical leaf gall on Eupatorium.

Endaphis Kieff. in the Americas (Dipt.). Entomological News 1911, 22:128–29

Arthrocnodax (Endaphis) abdominalis from Peru an Endaphis americana from Arizona described as new. Both wer reared from foliage infested with gall mites, Eriophyes.

Fumigation-poisoning. Country Gentleman, March 9, 1911 76:235[16]

A summary discussion of methods of fumigating for grain insects.

Insects and Scale Pests Common to New England and Bes Remedy for Each. Massachusetts Fruit Growers Associatio Reports 12–16, 1906–10, p. 7–12

A brief discussion of spraying followed by observations on the cas bearers, canker worms, the oyster scale, scurfy scale and the San José scal

The Increase and Control of San José Scale. Massachusett Fruit Growers Association Reports 12–16, 1906–10, p. 37–4

Summary discussion of control measures for Aspidiotu perniciosus Comst.

The Latest and Best Methods of Controlling Insects an Fungous Pests Attacking our Fruits and Ornamentals Massachusetts Fruit Growers Association Reports 12–16 1906–10, p. 84–93

Spraying methods with special reference to controlling the more com mon insect pests and fungous diseases.

Fruit Tree Insects and Their Control. Massachusetts Frui Growers Association Reports 12–16, 1906–10, p. 141–57

The San José scale, codling moth, plant lice and apple maggot wer discussed in detail, especially the first two.

Summary of Food Habits of American Gall Midges. Entomological Society of America Annals. 1911, 4:55–62

A summary of the food habits of the Itonidae and a comparison of our knowledge with that relating to European species.

A Generic Synopsis of the Itonidae. New York Entomological Society Journal, 19:31–62

A systematic arrangement of the genera with the synonymy. The following new genera were erected: Mycophila, Ceratomyia, Cordylomyia, Corinthomyia, Epimyia, Didactylomyia, Coccidomyia, Erosomyia and Diadiplosis. Meinertomyia and Xenodiplosis were proposed for the preoccupied Pero Mein. and Allodiplosis Rübs. not Kieff.

Elm Beetle.• Country Gentleman, March 30, 1911, 76:313[12]

Spraying with arsenate of lead is advised for controlling Galerucella luteola Müll.

Spraying an Apple Orchard. Country Gentleman, March 30, 1911, 76:314[11]

Thorough spraying with a lime-sulfur wash and arsenate of lead is advised for the control of the San José scale and codling moth, respectively.

Some Spraying Compounds. Country Gentleman, March 30, 1911, 76:314[22]

The preparation and use of the lime-sulfur wash is briefly discussed. A kerosene emulsion or whale oil soap solution is advised for the oyster scale and arsenate of lead for the codling moth.

26th Report of the State Entomologist on the Injurious and Other Insects of the State of New York. New York State Museum Bulletin 147, p. 1–180, 1911 (Issued April 5)

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Brown Mite. Country Gentleman, April 6, 1911, 76:337[33]

A discussion of control methods for the brown or clover mite, Bryobia pratensis Garm.

Miastor larvae. Canadian Entomologist, April 1911, 43:134–35 Science, April 14, 1911, 33:583; Economic Entomology Jour nal, 1911, 4:296; Entomological News, May 1911, 22:227; New York Entomological Society Journal, 19:200–1

Brief directions are given for finding these larvae and the cooperation of entomologists in collecting invited.

Gipsy and Brown-tail Moths. Country Gentleman, April 13 1911, 76:358[23]

A discussion of the moth situation in New England as shown by th report of the state forester of Massachusetts.

Bean Weevil. Country Gentleman, April 27, 1911, 76:409[44]

Summary discussion of control measures for Bruchus obtectu Say.

Endaphis hirta n. sp. Entomological News, May 1911, 22:22.

Original description of a Ceylonese species reared from Dactylopius.

A New Species of Lasioptera with Observations on Certain Homologies. Psyche, April 1911, 18:84–86

Original description of Lasioptera portulacae Felt with observations on the development of the acicula and the homology of the basal pouch in Asphondylia and the terminal lobes in females of other groups.

A Summer Spray. Country Gentleman, May 18, 1911, 76:480[41]

A brief discussion of summer sprays for the control of San José scale Aspidiotus perniciosus Comst.

Cutworms in the Garden. Country Gentleman, May 18, 1911 76:482[11]

Cutworms and their habits are described in connection with methods of controlling the pests.

Apple Borers. Country Gentleman, May 25, 1911, 76:502[36]

The habits and methods of controlling the round-headed borer Saperda candida Fabr. are briefly discussed.

Insects. Country Gentleman, May 25, 1911, 76:502[44]

A brief notice of Chermes floccus Patch on spruce and of the birch borer, Agrilus anxius Gory.

Two New Gall Midges. Canadian Entomologist, June 1911 43:194–96

Toxomyia rubida and Lobodiplosis coccidarum reared respectively from the aecidiospores of Uromyces and larvae preying on the eggs of Dactylopius, are described.

Billbugs in Corn. Country Gentleman, June 22, 1911, 76:586[17]

A brief economic account of the work of Sphenophorus species in corn.

Salt and Cutworms. Country Gentleman, June 22, 1911, 76:586[30]

Salt is considered to be of little service in controlling cutworms, pests most injurious when prolonged dry weather prevents normal plant growth.

Cicadas in New York. Country Gentleman, June 22, 1911, 76:590[42]

General observations on the abundance and distribution of the 1911 brood.

Rhopalomyia grossulariae n. sp. Economic Entomology Journal, 1911, 4:347

Description of a species destroying gooseberry buds in Ohio.

Rose Beetles. Country Gentleman, June 29, 1911, 76:607[16]

Arsenate of lead advised or the use of netting.

Silver-spotted Skipper. Country Gentleman, June 29, 1911, 76:607[28]

An outline is given of the life history of this butterfly.

Four New Gall Midges. Entomological News, July 1911, 22: 301–5

The new genus Toxomyia is erected. Asphondylia pattersoni reared from flowers of Citharexylum quadrangulare; Toxomyia fungicola reared from teleutospores of Puccinia on Emilia sonchifolia; Contarinia lycopersici from flowers of Lycopersicum esculentum and Hyperdiplosis coffeae from fruits of Coffea liberica are described.

Rose Leaf Hopper, Typhlocyba rosae Linn. Economic Entomology Journal, 1911, 4:413–14

Method of oviposition described.

Miastor. Economic Entomology Journal, 1911, 4:414

Observations on the food habits and biology.

Three New Gall Midges (Dipt.). New York Entomological Society Journal, 19:190–92

Holoneurus occidentalis, Lasiopteryx schwarzi and Hyperdiplosis americana are described, all reared from a decaying branch of wild fig.

Hosts and Galls of American Gall Midges. Economic Entomology Journal, 1911, 4:451–75

A tabulation of the galls and food habits of American Itonidae.

New Species of Itonidae. Economic Entomology Journal, 1911, 4:476–84

A new genus, Kronomyia is erected and the following species are described: Joanissia pennsylvanica, Kronomyia populi, Oligarces ulmi, Winnertzia pectinata, Rhizomyia hirta, Dasyneura communis, D. gibsoni, D. pergandei, D. smilacifolia, Cystiphora viburni, Asteromyia nigrina, A. reducta, Lasioptera allioniae, L. arizonensis, Neolasioptera agrostis, N. squamosa, N. trimera and Rhopalomyia gnaphalodis.

ADDITIONS TO COLLECTIONS, OCTOBER 17, 1910–OCTOBER 14, 1911

The following is a list of the more important additions to the collections:

DONATION

Hymenoptera

Thalessa atrata Fabr., black long sting, July 6, Mrs M. S. Miller, Boonville.

Rhodites bicolor Harr., spiny rose gall, old galls on rose, June 19, A. N. Baker, Bellport

Cynips ? prinoides Beutm., gall, September 14, J. A. Douglass, Oriskany Falls

Tremex columba Linn., pigeon tremex, adults on hickory, September 12, Sterling Wallace, New York City.

Caliroa cerasi Linn., cherry and pear slug, eggs on cherry, June 3, H. C. Sharpe, Schenectady

Kaliofenusa ulmi Sund., elm leaf miner, larvae on elm, May 30, J. H. Livingston, Tivoli. Same, May 31, Madam Howe, Kenwood. Same, June 16, Stephen Graff, Johnstown

Trichiocampus viminalis Fallen, poplar sawfly, larvae on poplar, August 30, W. H. Harris, Greenfield Center. Same, August 13, F. C. Helme, Chester

Abia inflata Nort., larvae on Lonicera, June 8, Leonard Barron, Garden City

Trichiosoma tibialis Steph., cocoon and pupa on Crataegus, April 10, Holland. Through State Department of Agriculture

Coleoptera

Eccoptogaster rugulosus Ratz., adult, August 8, Fisher Hyle, Germantown

E. quadrispinosus Say, adult on hickory, August 13, R. L. Cushman, Yonkers

Gymnetron teter Fabr., adult, June 21, C. E. Brisbin, Schuylerville

Rhynchites bicolor Fabr., rose curculio, adults and work, October 26, Miss G. W. Sargent, Lenox, Mass.

Pomphopoea sayi Lec., Say's blister beetle, adults, May 31, R. S. Nards, Slingerlands. Same, May 31, Smith Bowen, Hartford. Same, on locust blossoms, June 5, Matthew Hart, Castleton. Same, June 8, C. M. Winne, Castleton. Same, June 8, A. C. DeGarmo, Schuylerville. Same, June 14, Frank Jansen, Fonda. Same, June 16, J. G. Ward, Cambridge. Same, on cherry, June 20, Arthur Ward, Philmont. Same, June 21, C. E. Brisbin, Schuylerville

Meloe angusticollis Say, oil beetle, adult, September 15, C. E. Fairman, Lyndonville

Tribolium confusum Duv., confused flour beetle, adults, November 29, Miss E. Bush, Albany

Chalepus dorsalis Thunb., locust leaf miner, adults on locust, August 30, H. L. Frost & Bartlett Co., Stamford, Conn.

C. nervosa Panz., adult on locust, August 30, H. L. Frost & Bartlett Co., Stamford, Conn.

Systena taeniata Say var. blanda Melsh., adult on bean, June 29, J. F. Rose, South Byron

Galerucella luteola Müll., elm leaf beetle, larvae, June 28, F. B. Wicks, Ticonderoga. Same, larvae, pupae and adults on elm, July 6, H. L. Satterlee, Highland Falls. Same, eggs on elm, July 21, Miss S. L. Bell, Amsterdam. Same, adult on elm, August 7, Miss F. A. Wood, Poughkeepsie

Melasoma scripta Fabr., lined cottonwood beetle, egg, larvae and adult on poplar, August 18, Bloodgood Nurseries, Flushing. Through State Department of Agriculture

Crioceris asparagi Linn., asparagus beetle, adults on asparagus, May 19, John J. Hicks, Jericho

C. duodecim-punctata Linn., twelve-spotted asparagus beetle, adults on asparagus, May 19, John J. Hicks, Jericho

Saperda candida Fabr., round-headed appletree borer, adults on apple, May 25, W. H. Shutts, Claverack

Plectrodera scalator Fabr., banded poplar borer, adult, July 26, A. F. Onderdonk, Webster Groves, Mo.

Monohammus confusor Kirby, pine sawyer, larvae on pine, March 14, C. Y. Flanders, Tribes Hill. Same, June 5, Leland Wadsworth, Troy. Same, June 6, F. B. Pickering, Ballston Spa

Phymatodes variabilis Fabr., variable oak borer, adults, reared from oak, June 5, James Feeney, Meadowdale

Desmocerus palliatus Forst., cloaked knotty horn, adults on elder, June 2, F. T. Huxley, Amsterdam

Neoclytus erythrocephalus Fabr., adult on maple, June 16, Mount Vernon. Through State Department of Agriculture

Euphoria inda Linn., bumble flower beetle, adult, May 30, E. A. Baldwin, Schenectady

Anomala lucicola Fabr., light-loving grapevine beetle, adult, June 21, C. E. Brisbin, Schuylerville

Serica sericea Ill., adult, June 21, C. E. Brisbin, Schuylerville

Hoplia trifasciata Say, injuring pear blossoms from Greece, May 16, R. C. Draper, Rochester. Through State Department of Agriculture

Canthon laevis Dru., tumble bug or dung beetle, adult and dung ball, May 27, J. B. Scudder, Coxsackie

Amphicerus bicaudatus Say, work on cherry, June 23, R. H. Gibbes, Schenectady

Thelydrias contractus Mots., adult, pupal, larval skins, June 20, L. H. Joutel, New York City

Agrilus bilineatus Web., two-lined chestnut borer, larva on chestnut, August 30, S. K. Clapp, Brown Station. Through C. R. Pettis, superintendent state forests

Dicerca divaricata Say, adult, June 21, C. E. Brisbin, Schuylerville

Alaus oculatus Linn., eyed snapping beetle, adult, June 26, George Fischer, Albany

Xylina antennata Walk., green maple worm, larvae on maple, May 30, C. O. Horning, Amsterdam. Same, on soft maple, June 6, W. B. Westervelt, Newburg. Same, adult, April 27, C. J. Herrick, Albany

Papaipema nitela Guen., stalk borer, larvae, July 17, A. G. Harris, North Pelham

Heliothis armiger Hübn., corn worm or boll worm, larva in corn, October 13, H. B. Winters, Brooklyn. Through State Department of Agriculture

Melalopha inclusa Hübn., poplar tent maker, larvae on Carolina poplar, June 30, M. C. Albright, West Coxsackie

Datana ministra Dru., yellow-necked appletree caterpillar, July 20 Charles Fremd, North Rose. Same, August 25, F. M. Brooks, Athens

D. integerrima G. & Rob., black walnut caterpillar on pecan, July 28, Miss E. L. Keller, Eden

Schizura concinna Sm. & Abb., red-humped appletree caterpillar, July 12, A. G. Davis, Schenectady. Same, on apple, July 21, W. L. Bosworth, Amenia

Notolophus antiqua Linn, rusty tussock moth, eggs on box, March, nursery stock, Holland. Through State Department of Agriculture

Hemerocampa leucostigma Sm. & Abb., white-marked tussock moth, eggs, March 22, Thomas Tupper, Corning. Same, larva, May 29, J. A. Hepworth, Marlboro

H. definita Pack., eggs on poplar, April 5, Rochester. Through State Department of Agriculture

Tolype velleda Stoll., larch lappet moth, caterpillars on pear, July 25, West Coxsackie. Through State Department of Agriculture.

Malacosoma americana Fabr., apple tent caterpillar, June 5, G. F. Machure, Saranac Lake

M. disstria Hübn., forest tent caterpillar, June 11, Townsend Cox jr, Setauket. Same on maple, June 13, Miss A. Humphrey, Warsaw

Bombyx mori Linn., silk worm, cocoons on mulberry from North Italy, July 21, Arthur Paladin, Albany

Alsophila pometaria Harr., fall canker worm, moths and eggs, November 30, T. F. Niles, Rye. Through State Department of Agriculture. Same, eggs, February 23, White Plains. Through State Department of Agriculture. Same, moth, April 26, J. F. Hummer, Potsdam

Ennomos subsignarius Hübn., snow-white linden moth, eggs on beech, April 28, J. N. Smith, Margaretville.

E. magnarius Guen., eggs, February 16, P. M. Eastman, Coxsackie. Through State Department of Agriculture

Thyridopteryx ephemeraeformis Haw., bag worm, larvae, August 13, Mrs William Frech, Bayside

Cnidocampa flavescens Walk., Oriental slug caterpillar, cocoon on Japanese maple, March 23, nursery stock imported from Japan. Through State Department of Agriculture

Sibine stimulea Clem., saddle-back caterpillar, larva, August 30, C. L. Van Loan, Catskill. Same, larvae, September 29, R. MacGregor, Brooklyn

Euclea delphinii Boisd., larvae, August 25, Mynard DeFreest, Voorheesville

Phobetron pithecium Sm. & Abb., bag moth, larva, July 27, J. J. Barden, Sodus. Same, August 14, B. O. Burgin, St Johnsville

Codling moth work

Series 1

3*a* Sprayed thrice, picked fruit: 3879 sound, 3 wormy apples
4*d* Sprayed once late, picked fruit: 1809 sound, 131 wormy apples.
1′ Unsprayed, picked fruit: 1832 sound, 225 wormy apples

Chermes floccus Patch, gall on spruce, May 15, H. W. Wesson, Eggemoggin, Me. Through Country Gentleman

C. abietis Linn., spruce gall aphid, galls and adults on spruce, June 10, R. T. Conover jr, Bedford

C. pinicorticis Fitch, pine bark aphid, adults on pine, June 11, Arthur Clark, Garrison

Hamamelistes spinosus Shim., adults on birch, June 17, C. W. Goodyear, Tarrytown

Pemphigus ulmifusus Walsh, half grown galls on red or slippery elm, May 27, Stephen Graff, Johnstown

Phyllaphis fagi Linn., woolly beech aphis, adults on beech, June 15, M. N. Gardner, Brewster. Same, on beech, June 17, C. W. Goodyear, Tarrytown

Gossyparia spuria Mod., elm bark louse, adults on elm, June 10, J. D. Rogers, Round Lake. Same, May 31, Madam Howe, Kenwood

Phenacoccus acericola King, false cottony maple scale, adults on maple, May 29, Miss E. M. Briggs, Oneonta. Same, on hard maple, September 9, Miss J. N. White, New Rochelle, through State Conservation Commission. Same, on maple, June 8, T. R. Lawson, Troy. Same, larvae and adults on maple, August 31, C. W. Buckten, Mamaroneck. Same, young females, August 17, H. A. Unger, Clinton Heights. Same, young and females on maple, August 16, H. B. Wooster, Walden, through State Conservation Commission. Same, August 14, J. W. Small, North Tarrytown. Same, August 7, L. H. Crossman, New Rochelle. Same, July 20, A. J. Harcourt, Kingston. Same, male cocoons on maple, May 18, J. T. Lansing, Rensselaer. Same, young on maple, May 26, Benjamin Hammond, Fishkill

Pulvinaria vitis Linn., cottony maple scale, adults on maple, June 16, B. D. Van Buren, Mount Vernon, through State Department of Agriculture. Same, on maple, May 21, C. F. Nies, Salamanca. Same, adults and young on soft maple, July 21, C. C. Kekok, West Brighton

Lecanium scale, adults and young, June 20, Miss E. S. Blunt, New Russia

? Eulecanium magnoliarum Ckll., adults on maple, June 30, Miss A Humphrey, Warsaw

E. nigrofasciatum Perg., terrapin scale on soft maple, April 8, H. N. Babcock, Elmira. Same, on soft maple, April 29, M. DeForest Yates, Schenectady. Same, June 12, Miss S. A. Brown, Unadilla Forks

E. persicae Fabr., adult on mulberry, May 29, G. E. Ward, Ravena

? Saissetia oleae Bern., olive scale, adult on lemon, March 5, C. E. Olsen, Maspeth

Chionaspis pinifoliae Fitch, pine leaf scale, eggs on Scotch pine, September 27, S. G. Harris, Tarrytown

Diaspis carueli Targ., juniper scale, adults on Swedish juniper, September 27, A. E. Stene, Kingston, R. I.

Aulacaspis rosae Sandb., rose scale, egg on rose, November 18, Miss Rhoda Thompson, Ballston Spa. Same, April 26, E. J. Ritch, Kingston

Epidiaspis piricola Del Guer., pear scale, adult on French imported pear, January 16. Through the State Department of Agriculture

EXPLANATION OF PLATES

PLATE 1

137

Codling moth

A Two small apples, one end and the other side wormy. The former is the most common method of injury by apple worms or larvae of the first brood, while the other is very characteristic of larvae of the second brood and is usually confined to points where fruits touch or where a leaf and apple adhere.

B Group of blossoms ready to spray and showing conditions just after the petals drop. Note that the green sepal lobes are widely expanded or drooping, and that conditions are therefore favorable for filling the calyx cup with poison.

C Three mature apples showing the work of the apple worm or codling moth larva about the core, at the blossom end and an irregular cavity at the side, a point where the full grown larvae frequently escape

D A piece of bark removed from the tree and showing on the under surface the numerous cocoons in which the insects hibernate and undergo their transformations from the caterpillar to the pupa and moth

1 Moth with wings expanded, natural size

2 Moth resting on young apple, side view

3 Moth resting on leaf, seen from above

4 A portion of a pinkish apple worm or larva in a wormy apple

5 Cocoon, as seen from the under side and showing the hole made by a woodpecker in search of the apple worm or larva

6 Cell on the under side of the bark containing a codling moth worm or larva. Note its nearly doubled position.

7 Upper surface of bark showing hole made by a woodpecker. The same condition as seen from the inner surface is represented at 5.

8 Empty cocoon

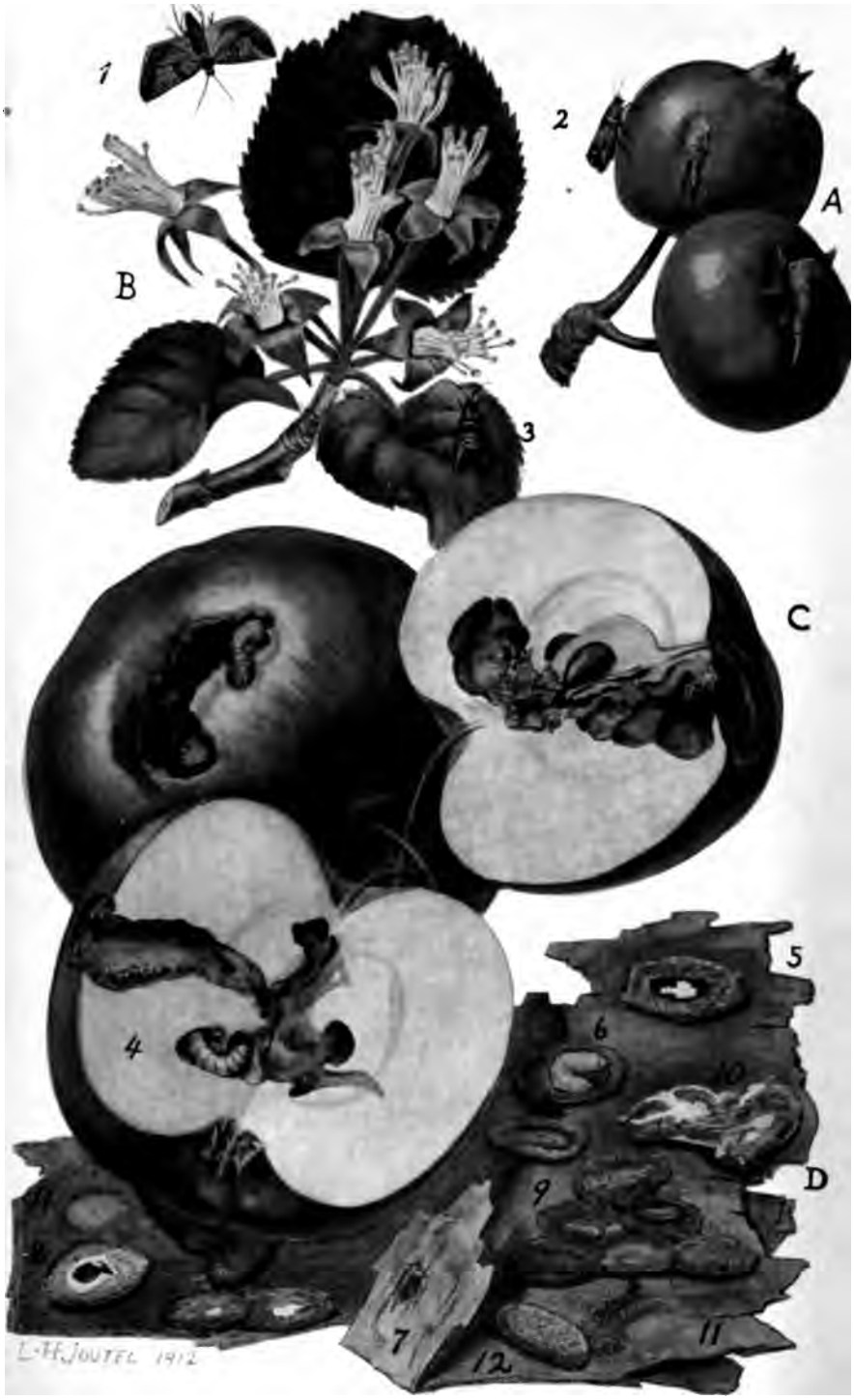
9 Group of old cocoons

10 Two cocoons in which apple worms or larvae have been destroyed by fungus

11 Oval excavation in the bark made by the apple worm or larva prior to spinning its cocoon

12 Newly made cocoon, the silken case being nearly obscured by particles of bark

Plate I



Codling moth and its work

PLATE 2

Codling moth work

Series *2*

1a Sprayed once, picked fruit: 2868 sound, 45 wormy apples
2b Sprayed twice, picked fruit: 5724 sound, 77 wormy apples

Plate 2

Codling moth work

PLATE 3

141

Codling moth work

Series 1

3*a* Sprayed thrice, picked fruit: 3879 sound, 3 wormy apples
4*d* Sprayed once late, picked fruit: 1809 sound, 131 wormy apples.
1' Unsprayed, picked fruit: 1832 sound, 225 wormy apples

Plate 3

Codling moth work

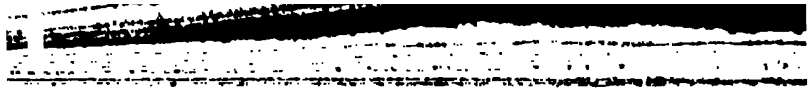


PLATE 4

143

Codling moth work

Series I

2c View showing loaded condition of tree
3a View showing loaded condition of tree

Plate 4

Trees in experimental orchard

Codling moth work

Series *2*

Two apples showing sun scald, followed by severe checking, from orchard of Edward Van Alstyne, October 1911

PLATE 5

145

Codling moth work

Series *2*

1a Sprayed once, picked fruit: 2868 sound, 45 wormy apples
2b Sprayed twice, picked fruit: 5724 sound, 77 wormy apples

Plate 5

Codling moth work

PLATE 6

147

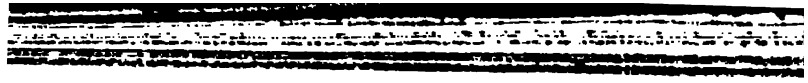
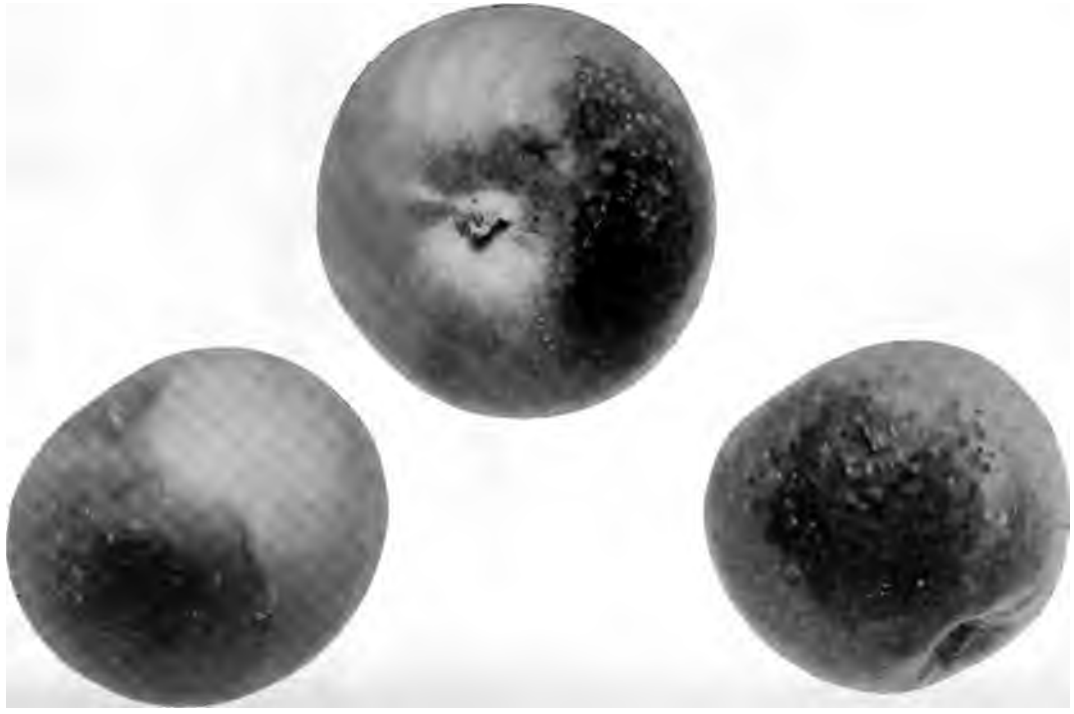


Plate 6



Apples affected by sun scald

...marked tussock moth, Hemerocamp ...
... x 200

... gipsy moth Porthetria dispar Linn. x 200

... brown gipsy moth larva. Porthetria dispa ...

... of gipsy moth, Porthetria dispar Linn ...
x 200

... gipsy moth larva. Porthetria dispa ...
Linn. x 200

... for mounting larva of gipsy moth, Porthetri ...
dispar Linn. x 225

... of gipsy moth, Porthetria dispar Linn ...

PLATE 7

149

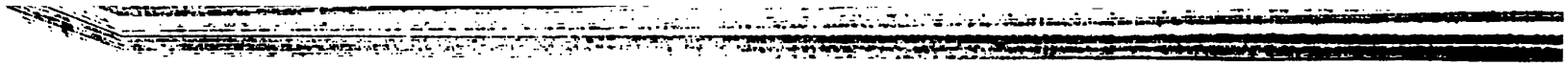


Plate 7

Checking following sun scald

Gipsy moth

Porthetria dispar Linn.

Defoliated apple orchard, Weston, Mass., June 29, 1911
Note the fruit and the vigorous untouched poison ivy foliage on trunks of the trees

PLATE 8

151

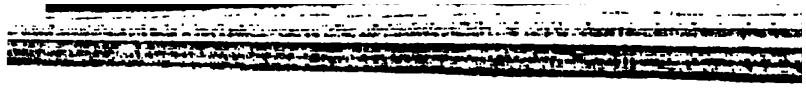


Plate 8

1

3

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4

Apple insects and a parasite

Gipsy moth

Porthetria dispar Linn.

Red oak near Weston, Mass., June 29, 1911. Many acres were defoliated like this, though a strip some 200 feet wide on each side of the road had been well protected by poison.

PLATE 9

153

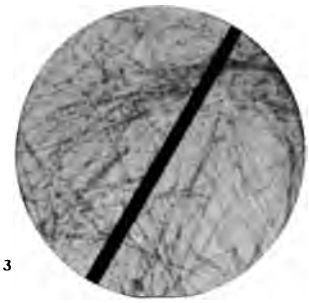
Gipsy moth

Porthetria dispar Linn.

Red oak near Weston, Mass., June 29, 1911. Many acres were defoliated like this, though a strip some 200 feet wide on each side of the road had been well protected by poison.

Plate 9

1



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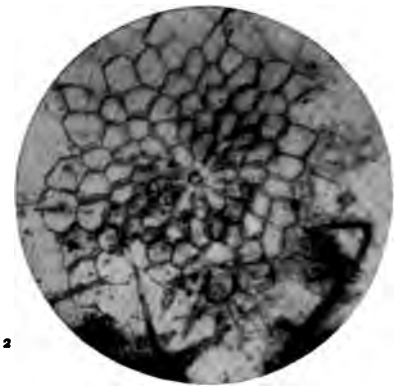

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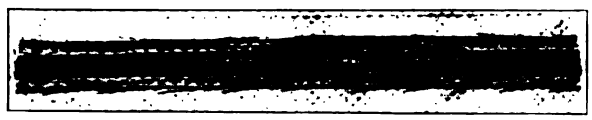

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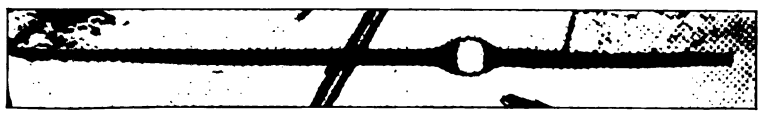

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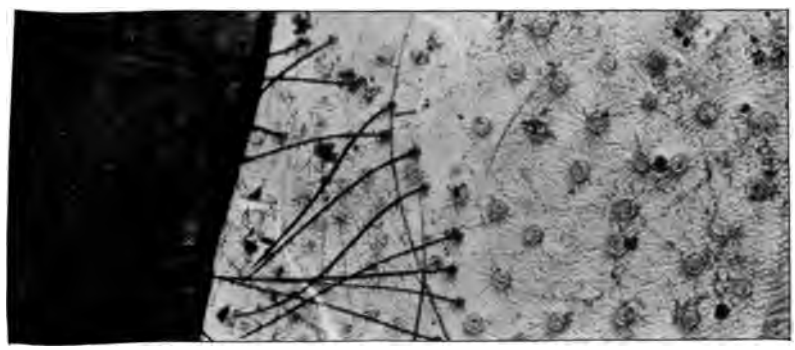


7

Gipsy moth structures

were defoliate

side of th

PLATE 10

155

Gipsy moth work 1911

Gipsy moth

Porthetria dispar Linn.

Practically clean stands of pine and maple near Metheun, Mass., June 30, 1911. These areas were protected simply by cutting out the favorite food plants and practically no injury resulted, as the young caterpillars were unable to develop upon either the pine or maple.

PLATE 11

157

Plate II

PLATE 12

159

Gipsy moth

Porthetria dispar Linn.

Practically clean stands of pine and maple near Metheun, Mass., June 30, 1911. These areas were protected simply by cutting out the favorite food plants and practically no injury resulted, as the young caterpillars were unable to develop upon either the pine or maple.

Clean stands of maple and pine uninjured by gipsy moth

PLATE 13

161

Brown-tail moth

Euproctis chrysorrhoea Linn.

Nests on young oaks near Salem, N. H. Photo June 30, 1911

Plate 13

Brown tail moth work 1911

PLATE 14

163

Green maple worm

Xylina antennata Walk.

Defoliated willows and maples, North Albany, N. Y., June 1911

164

Plate 14

Green maple worm work 1911

PLATE 15

165

Green maple worm

Xylina antennata Walk.

Defoliated soft maples at Amsterdam, N. Y., June 1911

Plate 15

Green maple worm work 1911

PLATE 16

167

Green maple worm

Xylina antennata Walk.

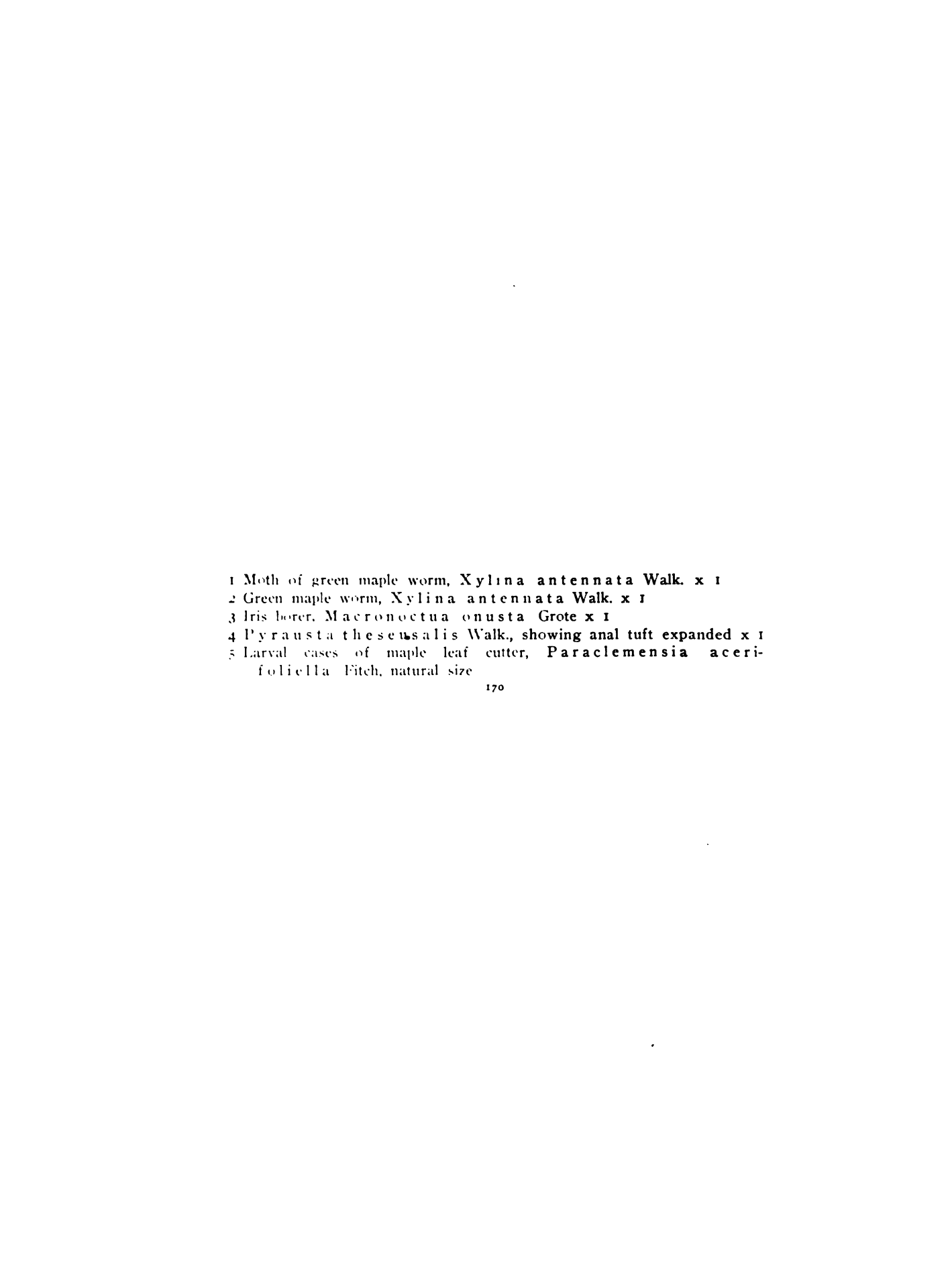
Soft maple sprouts badly ragged by caterpillars, Amsterdam, June 1911

Plate 16

Green maple worm work 1911

PLATE 17

169



1 Moth of green maple worm, Xylina antennata Walk. x 1
2 Green maple worm, Xylina antennata Walk. x 1
3 Iris borer, Macronoctua onusta Grote x 1
4 Pyrausta theseusalis Walk., showing anal tuft expanded x 1
5 Larval cases of maple leaf cutter, Paraclemensia acerifoliella Fitch, natural size

Plate 17

1

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2

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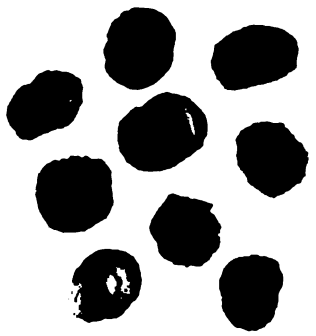


5

New York insects

PLATE 18

171

Maple leaf cutter

Paraclemensia acerifoliella Fitch

Soft maple leaves showing characteristic eating and several cases

Work of maple leaf cutter 1911

PLATE 19

173

Periodical Cicada

Tibicen septendecim Linn.

1 Pupa as it comes from the soil
2 Pupal shell just cracking
3 Pupa five minutes later, 10:01
4 Pupa two minutes later, 10:03
5 Emerging insect five minutes later, 10:08
6 Emerging insect three minutes later, 10:11

Plate 19

1

2

3

4

5

6

Cicada transformations

PLATE 20

Periodical Cicada

Tibicen septendecim Linn.

1 Emerging insect two minutes later than plate 18, fig. 6, 10:13
2 Emerging insect one minute later, 10:14
3 Insect crawling from the shell, 10:35
4 Insect resting on the empty shell, 10:36
5 Insect hanging beside the shell, 10:42
6 Insect hanging from the pupal shell. Note padlike wings. 9:45

Plate 20

1

2

3

4

5

Cicada transformations

PLATE 21

177

Periodical Cicada

Tibicen septendecim Linn.

1 Insect six minutes later than in plate 20, fig. 6, 9:51
2 Insect one minute later, 9:52
3 Insect one minute later, 9:53
4 Wings fully developed and partly wrapped around the body
5 Cicada fully colored as it appeared the next morning
6 Cicada with ovipositor partly inserted in a twig

Plate 21

1

2

3

4

5

6

Cicada transformations

PLATE 22

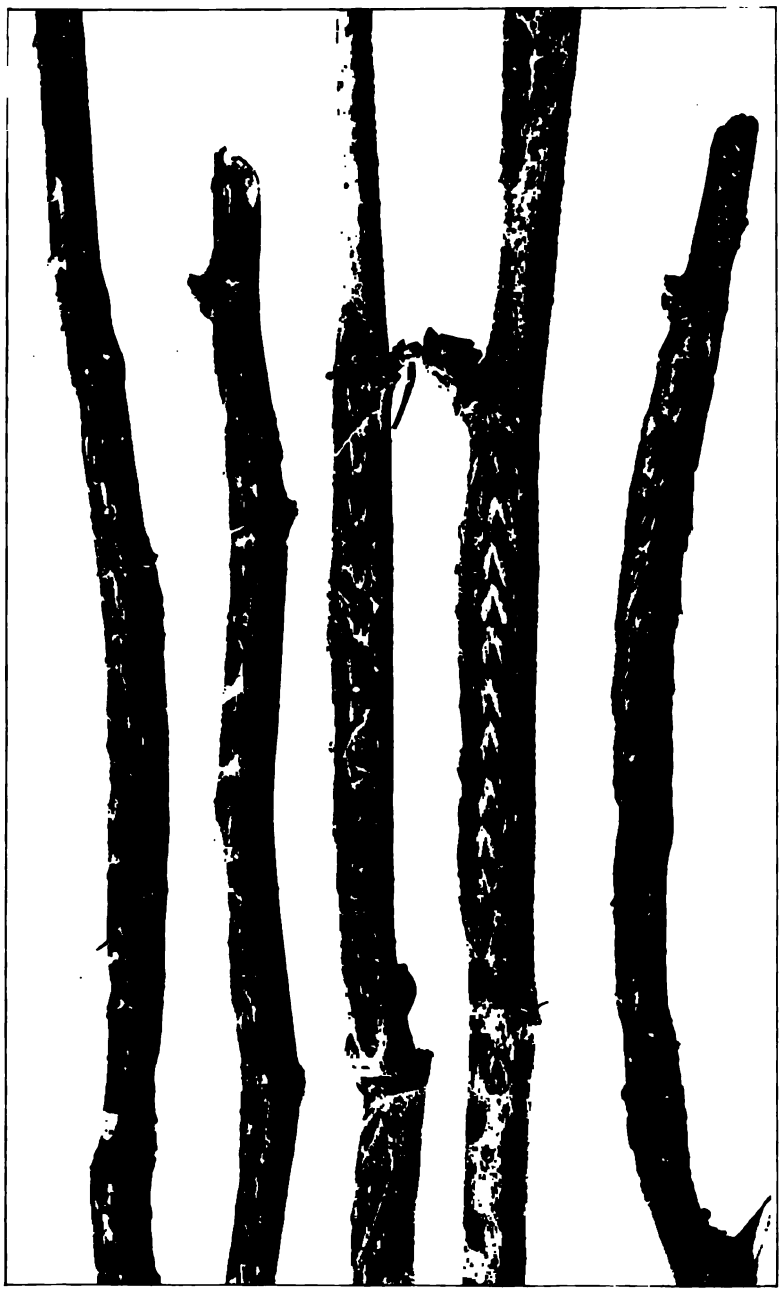
179

Periodical Cicada

Tibicen septendecim Linn.

Twigs showing oviposition scars

Plate 22



Cicada oviposition

PLATE 23

181

Periodical Cicada

Tibicen septendecim Linn.

Cicada chambers at New Baltimore, N. Y., June 1911

182

Plate 23

Cicada chambers above ground

PLATE 24

183

Periodical Cicada

Tibicen septendecim Linn.

View showing young orchard protected with netting from Cicada injury, New Baltimore, N. Y., June 1911

Plate 24

Trees netted to protect them from Cicadas

PLATE 25

185

White marked tussock moth

Hemerocampa leucostigma Sm. & Abb.

Defoliated linden at the corner of Eagle and Hamilton streets, Albany, N. Y.
Photo June 1911

Plate 25

White-marked tussock moth work

PLATE 26

187

Four-lined leaf bug

Poecilocapsus lineatus Fabr.

Wilder currant shoots showing the characteristic spotting caused by this pest

Plate 26

Four-lined leaf bug work

PLATE 27

189

1 Males of white marked tussock moth, Hemerocampa leucostigma Sm. & Abb. x 1

2 Female of white marked tussock moth, Hemerocampa leucostigma Sm. & Abb. depositing eggs on the filmy cocoon x 1

3 Cocoon of Cecropia moth, Samia cecropia Linn. containing numerous puparia of a parasitic fly, Frontina frenchii Will.

4 Pupa and larva of Xylophagus lugens Loew and larva (the larger one) of the allied X. abdominalis Lw.

Plate 27

1

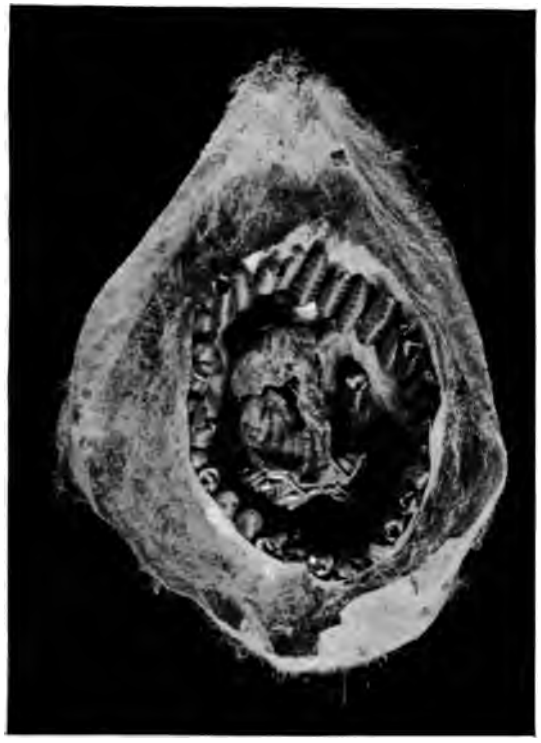


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Plate 26

Four-lined leaf bug work

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